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New Insights
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LIES

Everybody does it—because it works

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Really Mean

The **Magnetic Cure**

Stress and Your Heart

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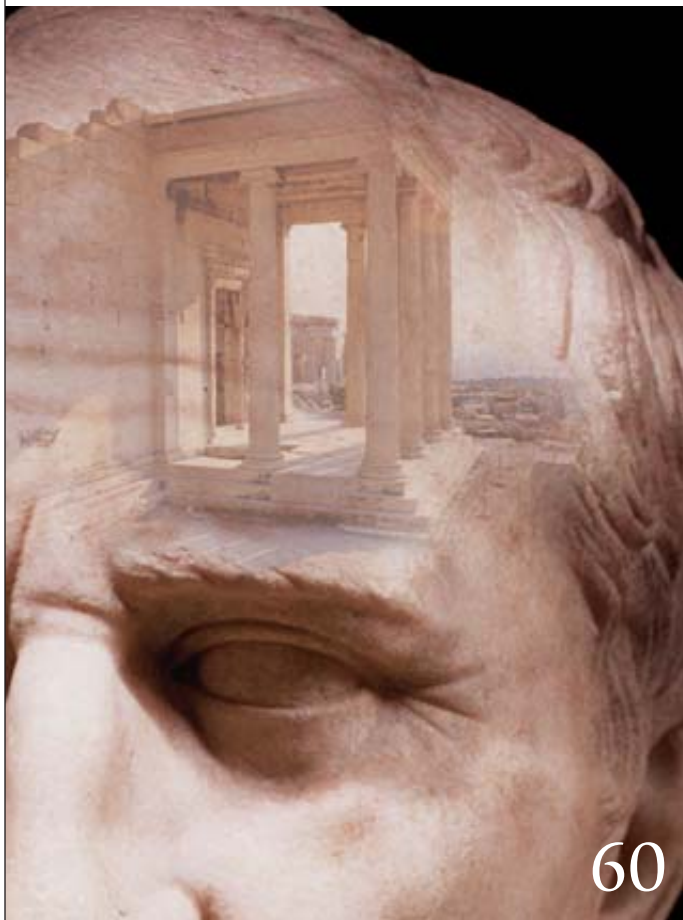
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True Lies

“Did you call him yet?” my boss asked. We were under pressure to finish a big editorial project, and the phone call was key to crucial details. I replied reflexively, without thinking: “I haven’t reached him yet.” My boss’s eyes flashed. “Wait a minute,” he said impatiently. “You tried him and you didn’t get through, or you haven’t called yet at all?” Whoops. I admitted that, in fact, I hadn’t called.

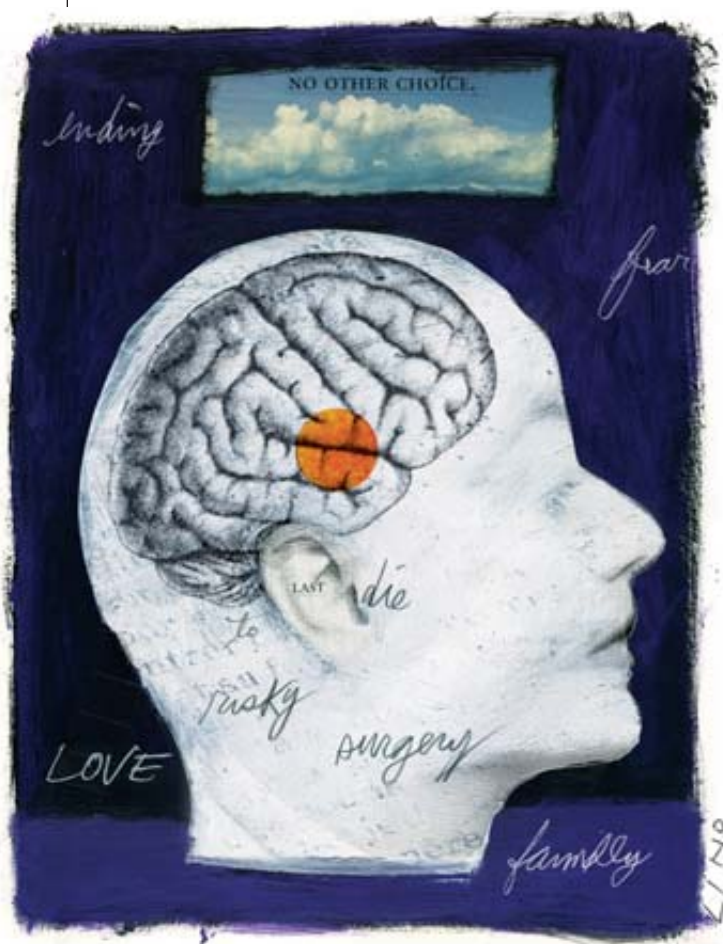
Since then, I have often wondered what made me respond so evasively. One of the benefits of working on *Scientific American Mind* is how often it provides not only a useful source of such constructive self-inspection but also the answers about what’s going on in my head. As a species, we humans lie at least several times a day, for reasons large and small, even though most of us condemn the habit. Our gift for dissembling has enabled societies to survive and thrive. Find out why in “Natural-Born Liars,” by David Livingstone Smith, on page 16.

Common wisdom would suggest that people fib when doing so helps them improve their personal situation in some way. But another article in this issue puts the lie to that notion. Under conditions common in routine crime investigations, suspects will say they’re guilty of committing a crime when they’re actually innocent. Perhaps 20 percent of all DNA exonerations have had false confessions in evidence. False confessions also affect how law-enforcement officers, attorneys, judges and juries treat defendants. Turn to page 24 for “True Crimes, False Confessions,” by Saul M. Kassin and Gisli H. Gudjonsson.

Maybe we shouldn’t be so hard on ourselves. After all, it’s difficult to get an accurate picture of the world we inhabit, as you’ll see in “Illusions,” by Vilayanur S. Ramachandran and Diane Rogers-Ramachandran, on page 96. If we focus on trying to count balls passed rapidly among basketball players, for instance, we can completely miss a person in a gorilla suit strutting across the floor. Sound far-fetched? Hey, are you going to believe us—or your lying eyes?

Mariette DiChristina
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KENN BROWN



Can They Hear Us?

Some patients with severe brain damage may be more aware than we think, according to the first study to assess their brain activity with imaging technology. Minds of minimally conscious patients appear to retain the ability to process language. The results are “a new voice for these patients,” says Columbia University professor Joy Hirsch, one author of the multi-institutional study.

A minimally conscious patient will occasionally respond to commands, reach for objects or make other purposeful gestures. In contrast, patients in a vegetative state show no such behavior; this was the case for Terri Schiavo, the Florida woman whose plight gained national attention in March. Hirsch and her colleagues compared functional magnetic resonance images of two minimally conscious patients with those of seven healthy subjects, taken as the individuals listened to recordings by loved ones about past experiences they had shared. The injured brains showed activity in the language centers of the temporal lobes that was strikingly similar to that in the healthy brains. But when the researchers played the narratives backward, the injured brains’ response was far inferior, perhaps indicating an inability to fully tap into their neural circuitry.

The possibility that minimally conscious patients could be tuned in to activity around them—such as bedside conversations among doctors and family members—without being able to respond underscores the limitations of current tests used to estimate consciousness, the researchers say. Additionally, having the “infrastructure for cognition in place suggests that it is at least theoretically possible” for these patients to regain some functions and perhaps return to a preinjury state, Hirsch notes. She and her co-workers continue to investigate how imaging might assess cognition and whether it can predict recovery.

—Aimee Cunningham

Head Lines

Whistle Spoken Here

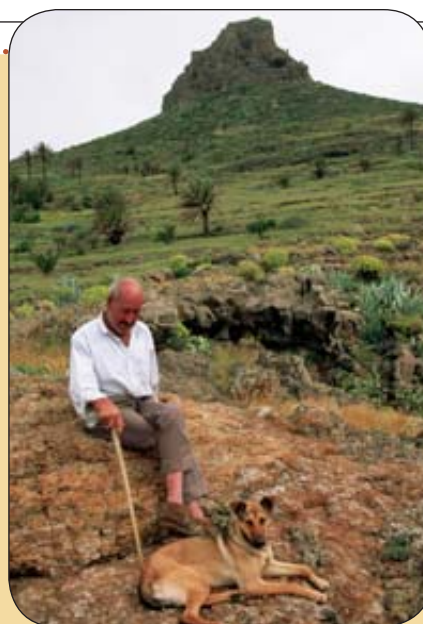
Shepherds on La Gomera in the Canary Islands communicate across long distances and over rough terrain with shrill whistles that represent Spanish word syllables. For example, those who know this “Silbo” language and are separated by a ravine can transmit a message like, “Meet you at the hill-top at three o’clock.” A team of Spanish and American psychologists studying Silbo has found that the whistlers’ brains treat the sounds as language, whereas the brains of Spaniards who do not know Silbo do not. This is clear evidence, says David Corina of the University of Washington, that “the language-processing regions of the human brain can adapt to a surpris-

ingly wide range of signaling forms.”

Corina and Manuel Carreiras of the University of La Laguna in the Canary Islands used functional neuroimaging to watch the subjects’ brains while they listened to recorded Silbo, spoken Spanish and nonsense whistling. The temporal regions of the left hemisphere associated with spoken-language function became active when whistlers heard Silbo sentences, which did not happen for Spanish speakers who do not understand Silbo. Unfortunately, few shepherds live on La Gomera today, and most have cell phones. Silbo is dying out.

—Jonathan Beard

Whistling shepherd of La Gomera.



LINO (top); NIK WHEELER Corbis (bottom)

Personality in Hand

If **divining personality** from finger length sounds like nonsense, Peter L. Hurd understands. An assistant professor of psychology at the University of Alberta, Hurd thought that such efforts “seemed like palmistry.” But now he is a believer.

Research had shown that the shorter a male's index finger is relative to his ring finger, the more testosterone he was exposed to as a fetus. Hurd has since found that men with a greater disparity are more prone to be physically aggressive throughout life.

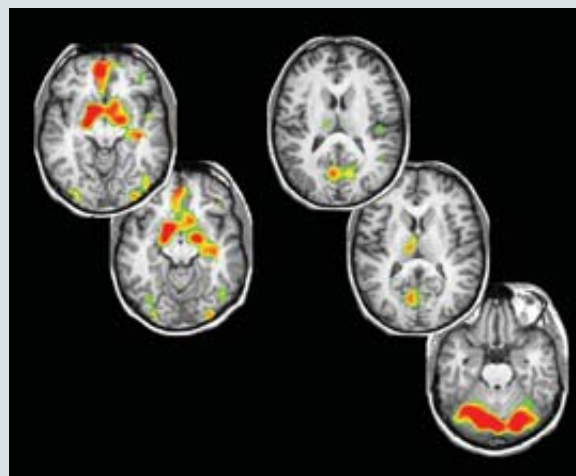
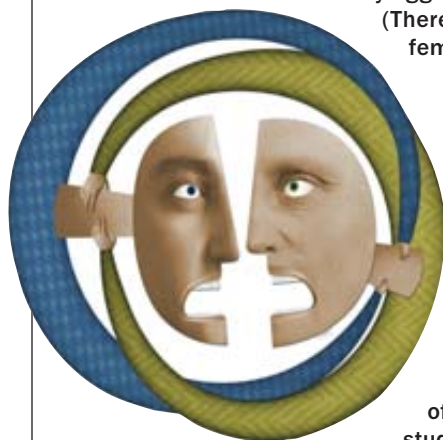
(There is no correlation for females.)

Although the association isn't strong enough to predict the trait, it is stronger than the relation between adult testosterone levels and aggression, a sign that “the causal effect of testosterone seems to be in the womb,” says Hurd, co-author of the just released study of 300 volunteers.

“The take-home message,” he

adds, “is that hormones during development explain far more variation in human behavior than hormones during adulthood.” Still skeptical? Bet you'll find it hard not to compare hands and personalities at your next party.

—Aimee Cunningham



Where Addiction Lies

When **smokers satisfy** their urge for a cigarette, they dampen their mental resistance to addiction. Researchers at the University of Michigan at Ann Arbor imaged smokers' cerebral blood flow as they puffed on a cigarette after a night of nicotine abstinence. They also took images as the subjects smoked a low-nicotine cigarette. Comparing the two images removed signs of activity related to the non-nicotine aspects of smoking, leaving a map of pure nicotine stimulation. The drug intake increased blood flow in areas rich in nicotine receptors (*left, orange*). But it also decreased blood flow in areas involved in memory formation and regions that normally moderate drug-seeking behavior (*right*). —Nicole Garbarini

Cooling Hot Aggression

Every day psychiatrists are called on to handle one of the most vexing problems in mental health: hot aggression. This impulsive, volatile behavior extends across many forms of mental illness, sending kids with autism or attention-deficit hyperactivity disorder into rages and contributing to crimes by people with undiagnosed mood disorders.

Surprisingly, the Food and Drug Administration's approved medicine cabinet contains nothing for treating aggression. So dozens of psychiatrists recently laid out a strong case for drug development, telling FDA officials that practitioners need medicines specifically designed for hotheadedness. “We need to view aggression as a common symptom, like fever,” says Peter Jensen, director of the Center for the Advancement of Children's Mental Health at Columbia University. “It's what gets kids hospitalized or placed in [supervised] residences or lands them in the juvenile justice system.”

Unlike the focused heat of a football player, say, hot aggression is impulsive and reactive. And whereas normal aggression is part of nature, Jensen says, hot aggression leads to wanton violence, such as barroom brawls and domestic violence. It dif-

fers, too, from the “cool” aggression psychopaths use to commit calculated crimes. It appears that different brain systems are involved.

Without dedicated drugs, doctors sometimes resort to off-label practice—prescribing a medication approved for a different ailment. One resort is lithium, a common treatment for bipolar illness (alternating bouts of mania and depression). Another is Risperdal, used for schizophrenia. But many such compounds have not been tested for aggression in clinical trials, and most seem ineffective.

Complicating matters is that the source of hot aggression is rarely diagnosed. This became clear to two doctors at Case Western Reserve University, Joseph Calabrese and Omar Elhaj, who recently screened 526 inmates in the Ottawa County Jail in Ohio for mood disorders. Of 165 subjects, 55 were diagnosed with bipolar disorder, 21 with major depression and seven with schizophrenia. Almost 80 percent of the total had no idea that they suffered from a diagnosable mental illness.

“These guys seem to get into trouble during manic episodes,” Calabrese says. “And they are the frequent fliers of the penal system.” The next step will be a treatment study to see if certain medications help to reduce the problematic impulses. —Jamie Talan



Looking at faces overstimulates autistic children.



New View on Autism

“Look me straight in the eye” is not something autistic children find easy to do. Avoiding eye contact is a hallmark of this developmental disorder, and researchers have looked for the cause in the brain’s fusiform gyrus region, active in face recognition. But instead of an underactive fusiform, says Kim Dalton, an assistant scientist at the University of Wisconsin–Madison, an overactive amygdala may be at fault.

Autism greatly weakens an individual’s capacity to socialize and communicate. Avoiding eye contact is a problem because it is a crucial source of “subtle cues that are critical for normal social and emotional development,” Dalton says. Working with Richard Davidson, a professor of psychiatry and psychology at the university, Dalton compared autistic teenagers with average teens. She observed their brains with magnetic resonance imaging as they looked at pictures of familiar faces and other faces that showed various emotions. The autistic teens took longer to recognize familiar faces and made more mistakes in identifying the emotions of others.

By tracking the subjects’ eye movements and brains, Dalton and Davidson found that the autistic children spent less time fixing their gaze on the eyes in the photographs. Yet the autistic group “showed greater activation of the amygdala and orbito-frontal gyrus”—areas associated with emotional response, Dalton says. These results suggest that in autistics, viewing faces causes overarousal of emotional centers, resulting in avoidance. The quieter fusiform response is a result, not a cause. Understanding this link may help scientists devise ways of training autistic children to look at faces, helping them form stronger social bonds.

—Jonathan Beard

Replacing Hamilton

The most popular method for monitoring depression is significantly flawed and needs replacement. So says R. Michael Bagby, clinical research director at the University of Toronto’s Center for Addiction and Mental Health. Although the Hamilton Depression Rating Scale, developed in 1960, has long been a “gold standard” in psychiatric evaluation, Bagby says its shortcomings are well noted.

Bagby was the lead researcher of a metastudy that analyzed 70 independent research papers on the Hamilton scale’s efficacy published since the last major review in 1979. The study was funded in part by Eli Lilly and the Ontario Mental Health Foundation.

Bagby says one of the scale’s greatest problems is poor sensitivity to changes in a depressed individual’s condition. This shortcoming makes it difficult to accurately monitor whether a patient is improving or declining and also confuses the approval of new antidepressant drugs, because the scale is a benchmark in judging their efficacy during clinical trials. Furthermore, the symptoms inventoried on the HAMD, as the scale is known, are simply out of step with modern research.

Although other scales have been introduced, none has achieved as widespread use as the Hamilton. In 1999 a cross-disciplinary team developed a revised version called the GRID-HAMD, but Bagby and his colleagues say that

the entire concept needs to be retired.

Kenneth Evans, director of medical and scientific services at Axon Communications and a key developer of the GRID-HAMD, acknowledges that the metastudy’s claims are valid. He is currently chair of the Depression Inventory

Development Team, a collaborative effort among clinical researchers and representatives from 14 pharmaceutical companies that seeks to develop a new screening tool. Initial versions are currently being tested for efficacy.

—Nicole Garbarini





Teen Control Backfires

What parents wouldn't be tempted to lock up their preteens ("tweens") until age 18? A study on adolescent perceptions of autonomy, however, finds that too much parental involvement is as problematic as too little. The research "highlights the difficult task that parents of early adolescents face," says lead author Sara Goldstein, an assistant psychology professor at the University of New Orleans.

The researchers queried 785 adolescents three times over four years: in seventh grade, about their social autonomy and parental relationships; in eighth grade, about peer influences; and in 11th grade, about problem behaviors

such as drinking and aggression. Kids given too much latitude, such as regularly staying at a friend's house after school with no adults present, were more likely to engage in riskier behaviors. But the same was true for kids whose parents were overly intrusive.

The goal, then, is balancing when to say no and when to let go, says co-author Pamela Davis-Kean, a developmental psychologist at the University of Michigan at Ann Arbor. For example, allow nights out but know who with and where. Or let tweens choose among supervised after-school activities. "It's important for parents to make adolescents feel like they do have some freedom," says Goldstein, while still setting limits. —Aimee Cunningham

Delaying Dementia

For a decade, neurologists have produced studies that suggest that adults who regularly challenge their brains in later life succumb to dementia less often, less severely and at older ages than seniors who are intellectually lazy. The mature brain can grow new neural connections and strengthen weak ones, if exercised. As with muscles, "use it or lose it" applies. A new study, however, suggests that mental activity in young adulthood also helps keep dementia at bay later.

A team of psychologists at the University of Toronto scanned the brains of 14 adults ages 18 to 30 and 19 seniors beyond age 65 as they performed various memory tests. Among the older subjects, those who had had the most education during their youth did the best and used their frontal lobes for recall. The top young participants primarily used their medial temporal lobes, which are employed to encode and think about new information. The team concluded that seniors may have trouble recruiting the temporal lobes and therefore rely on the frontal lobes—responsible for general cognition—to help out. But apparently, having pushed the brain further during their college days made that substitution more effective.

So if you want to be a clear thinker, or at least try to forestall dementia in your golden years, get as much formal education as you can when you are young. If you're already past that stage, then the experts say you should start challenging yourself now. Read, write, take classes, play cards, start a new hobby. Keep learning. Stay connected with friends and family, too; the interactions stimulate memory, concentration and mental processing. Also, control high blood pressure, elevated cholesterol and obesity; increasing evidence shows that these threats also predispose people to dementia. —Mark Fischetti

Alzheimer's Jam

The earliest trigger of Alzheimer's disease may be traffic jams occurring on the brain's cellular highways.

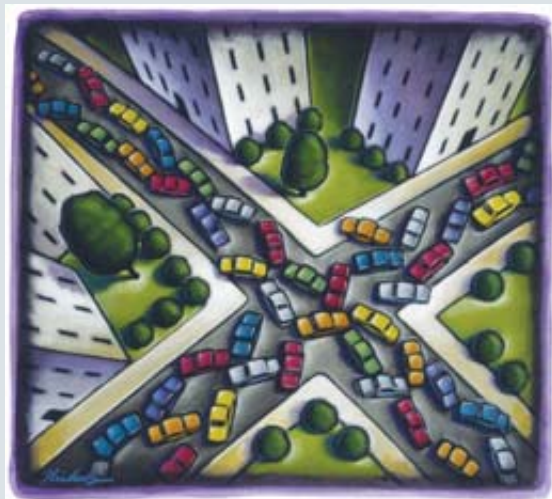
Researchers at the University of California at San Diego who led a multi-institutional study have found that prior to the formation of the destructive plaques that cause Alzheimer's, cellular debris accumulates along axons, whose long, thin fibers shuttle chemicals from neuron to neuron and from one brain neighborhood to the next. Clogging these transportation routes promotes the generation of plaque.

"It's choking up supply lines," says Lawrence S. B. Goldstein, professor of cellular and molecular medicine at the university. "It's like

a rock in a garden hose. The chemicals can't get through to do their job." By studying mice with the condition and the brains of people who died during early stages of Alzheimer's,

the scientists found that the more debris that exists on an axon highway, the harder that region is eventually hit with plaque.

In Alzheimer's, brain proteins called amyloid and tau are present in abnormal amounts, but researchers have long debated why. The new study indicates that congestion in axons is the likely culprit behind amyloid-filled plaques and tau-rich tangles. What's more, Goldstein says, the jams may explain tau's role in the disease process. Tau is key to regulating traffic on the axon highways, and even a slight blockage can lead to serious neuron damage. —Jamie Talan



Certain mental functions slow down with age, but the brain compensates in ways that can keep seniors just as sharp as youngsters **BY MARION SONNENMOSER**



A 16-year-old girl and her 70-year-old grandfather may use very different mental strategies to perform the same tasks—and they could both learn something from the other.

dence shows that older people are just as mentally fit as younger people, because their brains compensate for some kinds of declines in creative ways that young minds do not exploit as well.

Fast Mistakes

Just as a person's body ages at different rates, so does the mind. As adults advance in age, perception of sights, sounds and smells takes a bit longer, and laying down new information into memory becomes more difficult. The ability to retrieve memories quickly also slides. And it is sometimes harder to concentrate and maintain attention.

On the other hand, the aging brain can create significant advantages by tapping into its extensive store of knowledge and experience. The biggest trick that older brains employ is to use both hemispheres simultaneously to handle tasks for which younger brains rely on predominantly one side. Positron-emission tomography images taken by cognitive scientists at the University of Michigan at Ann Arbor, for example, have shown that even when doing basic recognition or memorization exercises, seniors exploit the left and right brain more extensively than men and women who are decades younger. Drawing on both sides of the brain gives them a tactical edge, even if the pure speed of each hemisphere's processing is slower.

In another experiment, Michael Falkenstein of the University of Dortmund in Germany found that when

Experience versus Speed

JAKE, AGED 16, has a terrific relationship with his grandmother Rita, who is 70. They live close by, and they even take a Spanish-language class together twice a week at a local college. After class they sometimes stop at a café for a snack. On one occasion Rita tells Jake, "I think it's great how fast you pick up new grammar. It takes me a lot longer." Jake replies: "Yeah, but you don't seem to make as many silly mistakes on the quizzes as I do. How do you do that?"

In that moment, Rita and Jake stumbled across an interesting set of differences between older and younger minds. Pop psychology says that as people age their brains "slow down." The implication, of course, is that elderly men and women are not as mentally agile as middle-aged adults or even teenagers. But although certain brain functions such as perception and reaction time do indeed take longer, that slowing down does not necessarily undermine mental acuity. Indeed, evi-

(Seniors **exploit the left and right brain** more extensively than men and women who are decades younger.)

TIM PANNELL Corbis

elders were presented with new computer exercises they paused longer before reacting and took longer to complete the tasks, yet they made 50 percent fewer errors, probably because of their more deliberate pace.

One analogy for these results might be the question of who can type a paragraph “better”: a 16-year-old who glides along at 60 words per minute but then has to double-back to correct a number of mistakes or a 70-year-old who strikes keys at only 40 words per minute but spends less time fixing errors. In the end, if “better” is defined as completing a clean paragraph, both people may end up taking the same amount of time.

Computerized tests support the notion that accuracy can offset speed. In one so-called distraction exercise, subjects were told to look at a screen, wait for an arrow that pointed in a certain direction to appear, and then use a mouse to click on it as soon as it shone on the screen. Just before the correct symbol appeared, however, the computer displayed numerous other arrows aimed in various other directions.

resonance imaging machine and concentrate on two different lists of printed words posted side by side in front of them. By looking at the lists, they were to find pairs of words that were similar in either meaning or spelling.

The eldest participants did just as well on the tests as the youngest did. And yet the MRI scans indicated that the elders’ left frontal and temporal



mechanisms used by younger men and women.

The reason aging brains can forge new capabilities that compensate for certain declines is that neuronal networks are surprisingly flexible, or “plastic.” They can adapt. Animal experiments prove that an intact nerve cell can take over the function of a neighboring nerve cell that has become damaged or that has simply withered with time. The brain creates ways to keep itself sharp by making these kinds of adjustments on a widespread scale over time.

Although researchers still know little about how to help the brain adapt to overcome the declines associated with aging, they do know that exercise—physical and mental—can provide some benefit. A rising number of studies have noted that senior citizens who stay more physically active have less deterioration in the brain than those who are sedentary [see “Smart Exercise,” by Aimee Cunningham; SCIENTIFIC AMERICAN MIND, Vol. 16, No. 1; 2005].

Even more studies show that peo-

(Crossword puzzles, book clubs, **political debate** and physical exercise can all stave off mental decline.)

Although younger subjects cut through the confusion faster when the properly positioned arrow suddenly popped up, they more frequently clicked on incorrect arrows in their haste.

Mental Gymnastics

Older test takers are equally capable of other tasks that do not depend on speed, such as language comprehension and processing. In these cases, however, the elders utilize the brain’s available resources in a different way. Neurologists at the Cognitive Neurology and Alzheimer’s Disease Center at Northwestern University came to this conclusion after analyzing 50 test subjects ranging in age from 23 to 78. The subjects had to lie down in a magnetic

lobes and certain visual centers, which together are responsible for language recognition and interpretation, were much less active. The researchers did find that the older people had more activity in brain regions responsible for attentiveness, such as the posterior cingulate cortex. Darren Gitelman, who headed the study, concluded that older brains solved the problems just as effectively but by different means.

Similar adaptation seems to aid memory, too. In 2003 Mara Mather and her colleagues at the University of California at Santa Cruz found that older adults who performed well on memory tests used a process of comparing bits of memories that was different from the memory-recollection

ple who continue to challenge themselves intellectually have lesser rates of Alzheimer’s disease and other forms of dementia and mental decline. Neurologists who have conducted such work recommend that people continue to engage in everything from crossword puzzles and book clubs to college courses and political debate. They can take up a musical instrument. Or learn a new language like Rita did. Not only will these vocations keep aging minds sharp, they will give their owners a sense of satisfaction in their never-ending mental powers.

MARION SONNENMOSER is a psychologist at the University at Landau in Germany and a freelance science journalist.

You volunteer as a normal subject for a study involving brain scans. Then researchers spot something abnormal in your head. Should they tell you? **BY JAMIE TALAN**

The Ethics of Scan and Tell

AS PART OF MY JOB reporting on neuroscience, I found myself in an unusual situation 10 years ago. During an interview, I offhandedly told a researcher to contact me if he ever needed a volunteer for a study. Months later the neurologist actually called, and I enrolled in a project on Parkinson's disease.

I was soon lying in a positron-emission tomography machine. Scientists injected a radioactive dye into my left arm, which felt warm and tingly as it coursed toward my brain. It settled in the regions that produce dopamine, a chemical that becomes depleted in Parkinson's. The researchers hoped that

brain scans of middle-aged people could reveal the earliest signs of dopamine loss.

My dopamine levels turned out to be very high, "the highest we've seen in a normal volunteer," the neurologist told me. But he and his colleagues had also found something unsuspected. They wanted me to undergo magnetic resonance imaging (MRI) to highlight one particular area. Alarmed, I agreed, and a few days later they took the MRI scan. There, in a dark corner of my cerebellum, was a large ghostly-white mass. It wasn't pretty. The researcher, who was not a physician, shrugged uncomfortably. The radiologist said

nothing. Many hours later the neurologist called and told me the shadow indicated a cyst and not to worry. I had probably had it since I was born.

What "IF" Scenarios

No one volunteers for a study expecting that something sinister may appear. But now, after more than a decade of brain-imaging research, scientists have run across the likes of me often, and they have finally pulled together to discuss the issue of such "incidental findings"—IF, for short. The findings range from tumors and blood clots to cysts and other structural abnormalities. Investigators simply don't



There, in a dark corner of my cerebellum, was a **ghostly-white mass**. The radiologist said nothing.

G. TOMPKINSON Photo Researchers, Inc.

know what to do when they happen on these anomalies in what are supposed to be “normal” test subjects.

This past January dozens of scientists, lawyers, ethicists and policymakers convened at the National Institutes of Health to debate the issue. It seems that incidental findings show up in 20 percent of subjects in research studies—a huge number—and there are still no official procedures for handling such discoveries. Judy Illes, a senior research scholar at the Stanford Center for Biomedical Ethics who organized the meeting, notes that researchers

search volunteers, our patients and our institutions,” Illes says.

Call a Doctor

B. J. Casey, a psychologist at Weill Medical College of Cornell University who took part in the NIH meeting, recounted the first time that her team stared at an odd white mass on the MRI scan of a normal volunteer. “We all realized it was something that shouldn’t be there,” Casey says. “But we aren’t doctors, we aren’t neuroradiologists, we’re researchers.”

Casey did call in a neuroradiologist,

“Researchers may be able to detect obvious abnormalities, but they don’t have the basic knowledge to make diagnoses,” says Ruth Macklin, a professor of bioethics at the Albert Einstein College of Medicine. Therefore, she maintains, the cost of a doctor or radiologist should be included.

Another vexing issue is that scans used for research are typically not as sophisticated as those in a clinical setting. As a result, the images might be harder to read and interpret by untrained eyes. Buying more expensive machines would further drive up study costs.

**“We aren’t doctors, we’re researchers.
We have to separate research from clinical practice.”**

typically are not medical doctors and shouldn’t be put in the position of practicing medicine. Yet they become good at sizing up scans. What should they do when they spot something? When should they scan and tell?

The answer is not easy, Illes and other experts note. Scans are like Rorschach tests: in the best hands, scans can still be interpreted differently. No one even agrees what a normal brain should look like.

“It’s a judgment call,” says David Eidelberg, director of neuroscience at the North Shore Long Island Jewish Health System in Manhasset, N.Y. “There are lots of variants of normal. Do you tell a person that they have a cyst in their brain that will never alter the course of their life? I’m not sure.”

This position, in essence, is that there is no reason to alarm a test subject unnecessarily. But others say volunteers should be told about any kind of unusual indications, whether it might worry them or not. It’s their brain, and they should be informed about it. The sticking point is that scientists have no uniform way of handling incidental findings. Illes and her colleagues want to adopt a basic framework to follow. “The idea is to come up with solutions to protect our re-

who concluded that the mass was a brain tumor. “We saved this person’s life,” she states. Nevertheless, the situation and others like it are uncomfortable. “We don’t want to enter into a patient-doctor interaction in a research study,” Casey says. “We have to separate research from clinical practice.” Then, she adds, the problem becomes, “How do you even know something is important enough to tell a person? Anything abnormal should be confirmed” first. Casey now runs pediatric scanning studies and shudders at the thought of “telling parents something is wrong with their child when it isn’t.”

Who tells a parent or an adult subject about an incidental finding is an issue, too. Scientists could simply say nothing; there is no requirement in a study scenario. Others might call in a doctor, and if the physician agrees something is suspicious he or she could refer the volunteer to a specialist. Alternatively, a researcher could advise a subject to contact his or her own doctor for follow-up. Or the scientist could call the doctor directly and have him or her address the patient.

Most studies do not include a physician, and participants at the meeting disagreed over whether they should factor a doctor into the cost of a study.

By meeting’s end the group at least agreed that the consent forms volunteers sign should lay out the possibility that a normal brain might not always look “normal.” The form could ask patients whether they want to know about what seem to be minor findings. And the document should specify that markers of potentially major abnormalities, such as a blood clot, aneurysm or tumor, would trigger immediate attention, whatever that might be. The group agreed to begin drafting guidelines for IFs, including the recommendation to inform subjects and when to refer them to a physician.

Given my own experience, I’m heartened that scientists are paying more attention to this problem. After all, I represent the normal volunteer who was abnormal. I’m glad to know that my dopamine levels are so high that I will probably never get Parkinson’s disease. And I’ve got a picture of my brain, the cyst hogging a good chunk of my cerebellum—the area that controls movement. If I do have any complications from that, it’s nothing more than a sore toe on my dancing partner’s foot.

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Neurolinguistic programming has become a favored pop psychology technique because it is easy to follow. But does it work?

BY SUSANNE KEMMER



Psychotherapy Lite

TOM'S COACH looks at him and begins: "The big conference room is full, and all eyes are on you at the podium. Try to picture it. Can you sense the crowd's anticipation? Who's sitting in the front row? How do you feel standing at the microphone?" These words awaken in Tom memories of earlier presentations, and the 33-year-old business manager gets queasy. He knows his company's future could hang on his upcoming pitch. So he has agreed, on the advice of co-workers, to try something called neurolinguistic programming (NLP) to steady his nerves.

Tom's coach tells him to back away from the podium, then asks, "When

was the last time you felt really good? Put yourself back in that situation." Tom, an accomplished runner, pictures himself triumphantly crossing the finish line at the end of his last marathon. "Close your eyes," the coach continues. "What do you see? How does it feel?" Tom sees the crowd and his girlfriend, who is beaming. "Try to hold on to that feeling while you come back to the present." The trainer now tells Tom to imagine making his presentation without losing his feeling of elation. Because Tom cannot do it initially, they repeat the procedure several more times. The goal is to make the topic of a future presentation

act like a signal that triggers positive feelings.

These techniques are part of neurolinguistic programming, which was developed in the mid-1970s by psychologist and linguist John Grinder and psychology graduate student Richard Bandler, both then at the University of California at Santa Cruz. They were trying to understand why some people handle pressure situations with ease and others do not. They looked closely at the work of three well-known psychotherapists: Fritz Perls, the founder of Gestalt therapy (which emphasizes self-awareness of one's feelings); family systems therapist Virginia Satir; and hypnotherapist Milton Erickson.

After much work, Grinder and Bandler claimed they had distilled the crucial elements of those techniques into one simplified therapeutic model. In contrast to other methods, NLP techniques were easy for laypeople to learn and even to teach, qualities that would open up the potential for those outside the psychology establishment to provide therapy.

Since then, Grinder and Bandler have gone their separate ways, and each has built a large business marketing NLP techniques. Bandler claims a trademark on both the term and its acronym, and in 1997 he sued Grinder for unfair methods of competition. NLP has become very popular among management and performance consultants, including "mental coaches" who advise everyone from business executives to athletes on skills ranging from public speaking to visualizing victory during competition. The techniques are also taught through seminars to entire companies, purportedly to show attendees how their firm can

(NLP's rise has taken place with **little scientific proof** of its effectiveness, causing some to discount its validity.)

GARY HOULDER Corbis

achieve maximum success. But NLP's steady rise has taken place with little scientific proof of its effectiveness, and its pop nature has caused some psychologists to discount the approach's validity. Is NLP a viable form of psychotherapy or a persistent fad?

Seeing Is Believing

Using simple exercises, NLP coaches try to help clients change their thinking, feelings or actions. Therapists also use NLP to treat psychological problems. For example, a patient who cannot shake the visions of a severe car accident, which causes him to feel that another crash is an ongoing threat, can consciously imagine the scene as blurry, less significant and more distant. As the image loses definition over time, the emotional sting subsides as well. NLP therapists tend not to ask, "What do you see?" but rather, "How do you see what you are seeing?" These techniques derive from several ideas: the assumption that all behavior derives from neurobiological processes, the belief in language as an instrument to order thoughts and behaviors, and the notion that thoughts and actions can be organized, or programmed, in a way that optimizes results. Hence, neuro-linguistic programming.

Perhaps the greatest strength of NLP is that the techniques are easily grasped. The subject is given training exercises that can be practiced on his or her own. For someone like Tom, who wants to achieve greater self-confidence during public speaking, this is not much of a problem. But in other cases, such as someone who wants to drastically change careers because of dissatisfaction, useful therapies can be much more complex. Some critics

Favorite NLP Techniques

Anchoring. A stimulus (say, having to give a speech) is linked to a reaction (imagined crowd applause), which the stimulus will trigger with regularity.

As if. A future event is imagined as already being over, to reduce anxiety. (If your exam were finished, what fun would you be having now?)

Reframing. The frame of reference of a problem is changed to alter its meaning. (Although your herniated disk means you can't go to work for a while, it's a good chance to engage in back-strengthening exercises that will improve your long-term health.)

Mirroring. Aspects of another person's behavior (facial expressions, body language) are copied to help create empathy or to form a closer relationship.

Timeline. The spirit of an event is cast in different time frames to change its emotional valence. (What would be the difference if your discussion took place a week from now or a year from now?)

Visualization. Images and concepts are imagined, to change emotions. (Picture yourself lying underneath a palm tree on a sunny beach.)

question whether the simple steps can help at all in such cases.

The methods on which NLP draws are not new [see box above]. For example, the "anchoring" Tom did comes from hypnotherapy. Some practitioners are accused of overestimating both the effects and the utility of these exercises. Purveyors who have a superficial outlook tout NLP as a panacea for all kinds of problems. NLP's respected proponents are more selective, of course, but even they have little scientific explanation for why the techniques supposedly work. In contrast to long-standing, proved approaches, such as behavioral or talk therapy, just a few isolated peer-reviewed studies have explored NLP's effectiveness, and these have found evidence only of very limited effects.

It is not as though Grinder and Bandler hadn't tried to give their invention scientific underpinnings 30 years ago. They used then current brain research to explain how their techniques worked. But they started from a number of presuppositions that had not been scientifically validated.

For example, the researchers postulated that each individual preferentially uses a certain sensory channel such as vision or hearing. If that were so, each of us would perceive information in a different way, a mechanism for which there is no evidence. But NLP's proponents say the proof is in the pudding. This is usually followed by an invitation to attend an NLP seminar and try the techniques directly.

Mind Control

Many people outside the business community are leery about NLP. It is not uncommon to hear comments

such as "It's some sort of mind control, right?" NLP supporters scoff at the notion that the exercises are simply instruments of manipulation. They say the techniques are transparent and that people come to sessions looking for personal change, a situation that cannot be called manipulation in the sense of devious mind control. Interestingly, NLP is gaining ground among physicians who are involved in wellness training, to help them communicate better with their patients and to work more effectively with patient groups with specific ailments, such as asthma.

And what about Tom? Will he become an ardent advocate of NLP? That will probably depend on how his presentation goes. If he aces it, he is likely to seek the services of his coach again for other difficult problems. And then neurolinguistic programming will perhaps become firmly anchored in his brain.

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Natural-Born Liars

WHY DO WE LIE, AND WHY ARE WE SO GOOD AT IT? BECAUSE IT WORKS

BY DAVID LIVINGSTONE SMITH

Deception runs like a red thread throughout all of human history. It sustains literature, from Homer's wily Odysseus to the biggest pop novels of today. Go to a movie, and odds are that the plot will revolve around deceit in some shape or form. Perhaps we find such stories so enthralling because lying pervades human life. Lying is a skill that wells up from deep within us, and we use it with abandon. As the great American observer Mark Twain wrote more than a century ago: "Everybody lies . . . every day, every hour, awake, asleep, in his dreams, in his joy, in his mourning. If he keeps his tongue still his hands, his feet, his eyes, his attitude will convey deception." Deceit is fundamental to the human condition.

Research supports Twain's conviction. One

good example was a study conducted in 2002 by psychologist Robert S. Feldman of the University of Massachusetts Amherst. Feldman secretly videotaped students who were asked to talk with a stranger. He later had the students analyze their tapes and tally the number of lies they had told. A whopping 60 percent admitted to lying at least once during 10 minutes of conversation, and the group averaged 2.9 untruths in that time period. The transgressions ranged from intentional exaggeration to flat-out fibs. Interestingly, men and women lied with equal frequency; however, Feldman found that women were more likely to lie to make the stranger feel good, whereas men lied most often to make themselves look better.

In another study a decade earlier by David Knox and Caroline Schacht, both now at East



**The Padded
Résumé: Lying
goes far beyond
spoken words;
we exaggerate,
falsify, flatter
and manipulate
in many ways.**



Carolina University, 92 percent of college students confessed that they had lied to a current or previous sexual partner, which left the husband-and-wife research team wondering whether the remaining 8 percent were lying. And whereas it has long been known that men are prone to lie about the number of their sexual conquests, recent research shows that women tend to underrepresent their degree of sexual experience. When asked to fill out questionnaires on personal sexual behavior and attitudes, women wired to a dummy polygraph machine reported having had twice as many lovers as those who were not, showing that the women who were not wired were less honest. It's all too ironic that the investigators had to deceive subjects to get them to tell the truth about their lies.

These references are just a few of the many examples of lying that pepper the scientific record. And yet research on deception is almost always focused on lying in the narrowest sense—literally saying things that aren't true. But our fetish extends far beyond verbal falsification. We lie by omission and through the subtleties of spin. We engage in myriad forms of nonverbal deception, too: we use makeup, hairpieces, cosmetic surgery, clothing and other forms of adornment to disguise our true appearance, and we apply artificial fragrances to misrepresent our body odors. We cry crocodile tears, fake or-

gasms and flash phony “have a nice day” smiles. Out-and-out verbal lies are just a small part of the vast tapestry of human deceit.

The obvious question raised by all of this accounting is: Why do we lie so readily? The answer: because it works. The *Homo sapiens* who are best able to lie have an edge over their counterparts in a relentless struggle for the reproductive success that drives the engine of evolution. As humans, we must fit into a close-knit social system to succeed, yet our primary aim is still to look out for ourselves above all others. Lying helps. And lying to ourselves—a talent built into our brains—helps us accept our fraudulent behavior.

Passport to Success

If this bald truth makes any one of us feel uncomfortable, we can take some solace in knowing we are not the only species to exploit the lie. Plants and animals communicate with one another by sounds, ritualistic displays, colors, airborne chemicals and other methods, and biologists once naively assumed that the sole function of these communication systems was to transmit accurate information. But the more we have learned, the more obvious it has become that nonhuman species put a lot of effort into sending *inaccurate* messages.

The mirror orchid, for example, displays

beautiful blue blossoms that are dead ringers for female wasps. The flower also manufactures a chemical cocktail that simulates the pheromones released by females to attract mates. These visual and olfactory cues keep hapless male wasps on the flower long enough to ensure that a hefty load of pollen is clinging to their bodies by the time they fly off to try their luck with another orchid in disguise. Of course, the orchid does not “intend” to deceive the wasp. Its fakery is built into its physical design, because over the course of history plants that had this capability were more readily able to pass on their genes than those that did not. Other creatures deploy equally deceptive strategies. When approached by an erstwhile predator, the harmless hog-nosed snake flattens its head, spreads out a cobralike hood and, hissing menacingly, pretends to strike with maniacal aggression, all the while keeping its mouth discreetly closed.

These cases and others show that nature favors deception because it provides survival advantages. The tricks become increasingly sophisticated the closer we get to *Homo sapiens* on the evolutionary chain. Consider an incident between Mel and Paul:

Mel dug furiously with her bare hands to extract the large succulent corm from the rock-hard Ethiopian ground. It was the dry season and food was scarce. Corms are edible bulbs somewhat like onions and are a staple during these long, hard months. Little Paul sat nearby and surreptitiously observed Mel’s labors. Paul’s mother was out of sight; she had left him to play in the grass, but he knew she would remain within earshot in case he needed her. Just as Mel managed,

The Lie of Happiness

Lying to ourselves may be one way of maintaining our mental health. Several classic studies indicate that moderately depressed people actually deceive themselves less than so-called normal folks. Lauren B. Alloy of Temple University and Lyn Y. Abramson of the University of Wisconsin–Madison unveiled this trend by clandestinely manipulating the outcome of a series of games. Healthy subjects who participated in the games were inclined to take credit when they won the rigged games and also typically underestimated their contributions to the outcome when they did poorly.

Depressed subjects, however, evaluated their contributions much more accurately. In another study, psychologist Peter M. Lewinsohn, professor emeritus at the University of Oregon, showed that depressives judge other people’s attitudes toward them far more accurately than nondepressed subjects. Furthermore, this ability actually degenerates as the psychological symptoms of depression lift in response to treatment.

Perhaps mental health rests on self-deception, and becoming depressed is based on an impairment of the ability to deceive oneself. After all, we are all going to die, all of our loved ones are going to die, and a great deal of the world lives in abject misery. These are hardly reasons to be happy! —D.L.S.

with a final pull, to yank her prize out of the earth, Paul let out an ear-splitting cry that shattered the peace of the savannah. His mother rushed to him. Heart pounding and adrenaline pumping, she burst upon the scene and quickly sized up the situation: Mel had obviously harassed her darling child. Shrieking, she stormed after the bewildered Mel, who dropped the corm and fled. Paul’s scheme was complete. After a

The Fake Smile

(Appearance: That was a funny story, boss.)

(Agenda: Give us that raise.)



	furtive glance to make sure nobody was looking, he scurried over to the corm, picked up his prize and began to eat. The trick worked so well that he used it several more times before anyone wised up. The actors in this real-life drama were not people. They were Chacma baboons, described in a 1987 article by primatologists Richard W. Byrne and Andrew Whiten of the University of St. Andrews in Scotland for <i>New Scientist</i> magazine and later recounted in Byrne's 1995 book <i>The Thinking Ape</i> (Oxford University Press). In 1983 Byrne and Whiten began noticing deceptive tactics among the mountain baboons in Dra-	ancestors to become progressively more intelligent and increasingly adept at wheeling, dealing, bluffing and conniving. That means human beings are natural-born liars. And in line with other evolutionary trends, our talent for dissembling dwarfs that of our nearest relatives by several orders of magnitude. The complex choreography of social gamesmanship remains central to our lives today. The best deceivers continue to reap advantages denied to their more honest or less competent peers. Lying helps us facilitate social interactions, manipulate others and make friends. There is even a correlation between social popularity and deceptive skill. We falsify our re-	
		The Thumbs-Up (Appearance: Great to see you. You're the best.) (Agenda: Pick me for that VP job.)	
	kensberg, South Africa. Catarrhine primates, the group that includes the Old World monkeys, apes and ourselves, are all able to tactically dupe members of their own species. The deceptiveness is not built into their appearance, as with the mirror orchid, nor is it encapsulated in rigid behavioral routines like those of the hog-nosed snake. The primates' repertoires are calculated, flexible and exquisitely sensitive to shifting social contexts. Byrne and Whiten catalogued many such observations, and these became the basis for their celebrated Machiavellian intelligence hypothesis, which states that the extraordinary explosion of intelligence in primate evolution was prompted by the need to master ever more sophisticated forms of social trickery and manipulation. Primates had to get smart to keep up with the snowballing development of social gamesmanship. The Machiavellian intelligence hypothesis suggests that social complexity propelled our	sumés to get jobs, plagiarize essays to boost grade-point averages and pull the wool over the eyes of potential sexual partners to lure them into bed. Research shows that liars are often better able to get jobs and attract members of the opposite sex into relationships. Several years later Feldman demonstrated that the adolescents who are most popular in their schools are also better at fooling their peers. Lying continues to work. Although it would be self-defeating to lie all the time (remember the fate of the boy who cried, "Wolf!"), lying often and well remains a passport to social, professional and economic success. Fooling Ourselves Ironically, the primary reasons we are so good at lying to others is that we are good at lying to ourselves. There is a strange asymmetry in how we apportion dishonesty. Although we are often ready to accuse others of deceiving us,	CHABRUEN Getty Images
20	COPYRIGHT 2005 SCIENTIFIC AMERICAN, INC.		SCIENTIFIC AMERICAN MIND

we are astonishingly oblivious to our own duplicity. Experiences of being a victim of deception are burned indelibly into our memories, but our own prevarications slip off our tongues so easily that we often do not notice them for what they are.

The strange phenomenon of self-deception has perplexed philosophers and psychologists for more than 2,000 years. On the face of it, the idea that a person can con oneself seems as nonsensical as cheating at solitaire or embezzling money from one's own bank account. But the paradoxical character of self-deception flows from the idea, formalized by French polymath René Descartes in the 17th century, that human minds are transparent to their owners and that introspection yields an accurate understanding of our own mental life. As natural as this perspective is to most of us, it turns out to be deeply misguided.

If we hope to understand self-deception, we need to draw on a more scientifically sound conception of how the mind works. The brain comprises a number of functional systems. The system responsible for cognition—the thinking part of the brain—is somewhat distinct from the system that produces conscious experiences. The relation between the two systems can be thought of as similar to the relation between the processor and monitor of a personal computer. The work takes place in the processor; the monitor does nothing but display information the processor transfers to it. By the same token, the brain's cognitive systems do the thinking, whereas consciousness displays the information that it has received. Consciousness plays a less important role in cognition than previously expected.

This general picture is supported by a great deal of experimental evidence. Some of the most remarkable and widely discussed studies were conducted several decades ago by neuroscientist Benjamin Libet, now professor emeritus at the University of California at San Diego. In one experiment, Libet placed subjects in front of a button and a rapidly moving clock and asked them to press the button whenever they wished and to note the time, as displayed on the clock, the moment they felt an impulse to press the button. Libet also attached electrodes over the motor cortex, which controls movement, in each of his subjects to monitor the electrical tension that mounts as the brain prepares to initiate an action. He found that our brains begin to prepare for action just over a third of a second *before we consciously decide to act*. In other words, de-

Big-Brained Bamboozlers

Homo sapiens have big brains. So do our relatives, the monkeys and apes. Normally, brain size among species rises with increasing body size and metabolic intake, but according to this formula, monkeys and apes have the brain volume of creatures twice as large. Most of the enlargement comes from massive development of the neocortex. A 2004 study by Richard W. Byrne and Nadia Corp of the University of St. Andrews in Scotland shows that the use of deception by primate species rises with neocortical volume. That is, the members of species with the beefiest brains are most inclined to deceive one another. Human brain size, of course, outranks all others on the body-size chart.

—D.L.S.

spite appearances, it is not the conscious mind that decides to perform an action: the decision is made unconsciously. Although our consciousness likes to take the credit (so to speak), it is merely informed of unconscious decisions after the fact. This study and others like it suggest that we are systematically deluded about the role consciousness plays in our lives. Strange as it may seem, consciousness may not do anything except display the results of unconscious cognition.

This general model of the mind, supported by various experiments beyond Libet's, gives us exactly what we need to resolve the paradox of self-deception—at least in theory. We are able to deceive ourselves by invoking the equivalent of a cognitive filter between unconscious cognition and conscious awareness. The filter preempts information before it reaches consciousness, preventing selected thoughts from proliferating along the neural pathways to awareness.

Solving the Pinocchio Problem

But why would we filter information? Considered from a biological perspective, this notion presents a problem. The idea that we have an evolved tendency to *deprive* ourselves of information sounds wildly implausible, self-defeating and biologically disadvantageous. But once again we can find a clue from Mark Twain, who bequeathed to us an amazingly insightful expla-

(The Author)

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The Come-On:
“You’re the
sexiest woman
at this party.”
(Agenda: Come
home with me
tonight.)



nation. “When a person cannot deceive himself,” he wrote, “the chances are against his being able to deceive other people.” Self-deception is advantageous because it helps us lie to others more convincingly. Concealing the truth from ourselves conceals it from others.

In the early 1970s biologist Robert L. Trivers, now at Rutgers University, put scientific flesh on Twain’s insight. Trivers made the case that our flair for self-deception might be a solution to an adaptive problem that repeatedly faced ancestral humans when they attempted to deceive one another. Deception can be a risky business. In the tribal, hunter-gatherer bands that were presumably the standard social environment in which our hominid ancestors lived, being caught red-handed in an act of deception could result in social ostracism or banishment from the community, to become hyena bait. Because our ancestors were socially savvy, highly intelligent primates, there came a point when they became aware of these dangers and learned to be self-conscious liars.

This awareness created a brand-new problem. Uncomfortable, jittery liars are bad liars. Like Pinocchio, they give themselves away by involuntary, nonverbal behaviors. A good deal of experimental evidence indicates that humans are remarkably adept at making inferences about one another’s mental states on the basis of even minimal exposure to nonverbal information. As Freud once commented, “No mortal can keep a

Better Polygraphs

Although advocates of the polygraph claim an accuracy rate around 90 percent, many critics say the number is closer to 60 percent. The problem is that despite its “lie detector” moniker, the machine does not really spot falsehoods. Its electrodes, arranged in various places on a subject’s body, measure physiological signs of stress, such as elevated heart rate and blood pressure. These do often accompany lying, but if a person can lie calmly he or she stands a good chance of beating the polygraph. Conversely, a truth-telling individual who is anxious about the procedure can elicit a false positive reading.

Scientists are working on a new breed of lie detectors that zeros in on lying itself. For example, neuroscientist Lawrence A. Farwell of Brain Fingerprinting Laboratories has developed a method of the same name. A subject wears a helmet of electrodes that produces an electroencephalogram (EEG)—a record of electrical changes in the brain. By monitoring neural activity this way, Farwell

claims he can detect dishonesty with nearly 100 percent accuracy. The method relies on telltale signs of visual recognition in the brain. For example, a suspect who is shown a murder weapon may say that he has never seen it before, but his brain, Farwell maintains, will generate a wave called P300 that automatically occurs when we recognize an object.

Another approach is being pioneered by psychologist Stephen M. Kosslyn of Harvard University. Kosslyn uses imaging technologies to study what the brain does when we lie. His findings indicate that lying is associated with greater brain activity than truth telling and that activity in certain areas of the brain is associated with distinct kinds of lies.

Although these methods and others remain controversial, it is most likely that the next decade will give investigators unprecedented access to the secret recesses of our minds—for good or for ill.

—D.L.S.

GETTY IMAGES



The Forced Cry

(Appearance: You hurt my feelings.)
(Agenda: Take me out for a lavish evening, and I might forgive you.)

secret. If his lips are silent, he chatters with his fingertips; betrayal oozes out of him at every pore.” In an effort to quell our rising anxiety, we may automatically raise the pitch of our voice, blush, break out into the proverbial cold sweat, scratch our nose or make small movements with our feet as though barely squelching an impulse to flee.

Alternatively, we may attempt to rigidly control the tone of our voice and, in an effort to suppress telltale stray movements, raise suspicion by our stiff, wooden bearing. In any case, we sabotage our own efforts to deceive. Nowadays a used-car salesman can hide his shifty eyes behind dark sunglasses, but this cover was not available during the Pleistocene epoch. Some other solution was required.

Natural selection appears to have cracked the Pinocchio problem by endowing us with the ability to lie to ourselves. Fooling ourselves allows us to selfishly manipulate others around us while remaining conveniently innocent of our own shady agendas.

If this is right, self-deception took root in the human mind as a tool for social manipulation. As Trivers noted, biologists propose that the overriding function of self-deception is the more fluid deception of others. Self-deception helps us ensnare other people more effectively. It enables us to lie sincerely, to lie without knowing that we are lying. There is no longer any need to put on an act, to pretend that we are telling the truth. Indeed, a self-deceived person is actually telling the truth to the best of his or her knowledge, and believing one’s own story makes it all the more persuasive.

Although Trivers’s thesis is difficult to test, it has gained wide currency as the only biological-

ly realistic explanation of self-deception as an adaptive feature of the human mind. The view also fits very well with a good deal of work on the evolutionary roots of social behavior that has been supported empirically.

Of course, self-deception is not always so absolute. We are sometimes aware that we are willing dupes in our own con game, stubbornly refusing to explicitly articulate to ourselves just what we are up to. We know that the stories we tell ourselves do not jibe with our behavior, or they fail to mesh with physical signs such as a thumping heart or sweaty palms that betray our emotional states. For example, the students described earlier, who admitted their lies when watching themselves on videotape, knew they were lying at times, and most likely they did not stop themselves because they were not disturbed by this behavior.

At other times, however, we are happily unaware that we are pulling the wool over our own eyes. A biological perspective helps us understand why the cognitive gears of self-deception engage so smoothly and silently. They cleverly and imperceptibly embroil us in performances that are so skillfully crafted that the act gives every indication of complete sincerity, even to the actors themselves.

(Further Reading)

- ◆ **On the Decay of the Art of Lying.** Mark Twain in *The Stolen White Elephant, Etc.* James R. Osgood and Company, 1882.
- ◆ **The Thinking Primate’s Guide to Deception.** Richard W. Byrne and Andrew A. Whiten in *New Scientist*, No. 1589, pages 54–57; December 3, 1987.
- ◆ **Who Lies?** Deborah A. Kashy and Bella M. DePaulo in *Journal of Personality and Social Psychology*, Vol. 70, No. 5, pages 1037–1051; 1996.
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Why do innocent people confess to crimes they did not commit?

By Saul M. Kassin and Gisli H. Gudjonsson

TRUE CRIMES FALSE CONFESSIONS

In 1989 a female jogger was beaten senseless, raped and left for dead in New York City's Central Park. Her skull had multiple fractures, her eye socket was crushed, and she lost three quarters of her blood. She survived, but she cannot remember anything about the incident. Within 48 hours of the attack, solely on the basis of confessions obtained by police, five African- and Hispanic-American boys, 14 to 16 years old, were arrested. The crime scene had shown a horrific act but carried no physical traces at all of the defendants. Yet it was easy to under-

stand why detectives, under the glare of a national media spotlight, aggressively interrogated the teenagers, at least some of whom were "wilding" in the park that night.

Four of the confessions were videotaped and later presented at trial. The tapes were compelling, with each of the defendants describing in vivid—though, in many ways, erroneous—detail how the jogger was attacked and what role he had played. One boy reenacted the way he pulled off her running pants. Another said he felt pressured by the others to participate in his "first rape";



he expressed remorse and promised that it would not happen again. After their arrest, the youths recanted these confessions, because they had believed that making a confession would have enabled them to go home. Regardless of the denials, the tapes collectively persuaded police, prosecutors, two trial juries, a city and a nation; the teenagers were convicted and sentenced to prison.

Thirteen years later Matias Reyes, who was in jail for three rapes and a murder committed after the jogger attack, stepped forward of his own initiative. He volunteered that he was the Central Park assailant and that he had acted alone. The Manhattan district attorney's office questioned Reyes and discovered that he had accurate, privileged and independently corroborated

crime? A scan of the scientific literature reveals how a complex set of psychological factors comes into play. First, techniques commonly used by investigators during interviews make them prone to see deceit in suspects, a perception that tends to bias the outcome of the questioning. When the accused waive their constitutional rights to silence and to counsel during questioning by the police, they may also unwittingly lose procedural safeguards and put themselves at greater risk of making a false confession. Other contributors include a given person's tendencies toward compliance or suggestibility in the face of two common interrogation tactics—the presentation of false incriminating evidence and the impression that giving a confession might bring leniency. In

(A disturbing number of cases have involved defendants who were convicted based only on false confessions.)

rated knowledge of the crime and crime scene. DNA testing further revealed that the semen samples recovered from the victim—which had conclusively excluded the boys as donors—belonged to Reyes. (Prosecutors had argued at trial that just because police did not capture *all* the alleged perpetrators did not mean they did not get *some* of them.) In December 2002 the five teenagers' convictions were vacated.

Despite its notoriety, the case illustrates a phenomenon that is not new or unique. The pages of legal history reveal many tragic miscarriages of justice involving innocent men and women who were prosecuted, wrongfully convicted, and sentenced to prison or to death. Opinions differ on prevalence rates, but it is clear that a disturbing number of cases have involved defendants who were convicted based only on false confessions that, at least in retrospect, could not have been true. Indeed, as in the case of the Central Park incident, disputed false confessions have convicted some people notwithstanding physical evidence to the contrary. As a result of technological advances in forensic DNA typing—which enables the review of past cases in which blood, hair, semen, skin, saliva or other biological material has been preserved—many new, high-profile wrongful convictions have surfaced in recent years, up to 157 in the U.S. alone at the time of this writing. Typically 20 to 25 percent of DNA exonerations had false confessions in evidence.

Why would an innocent person confess to a

short, sometimes people confess because it seems like the only way out of a terrible situation.

More troubling, confession evidence is inherently prejudicial, influencing juries even when they are shown evidence of coercion and even when there is no corroboration. Ultimately, we believe, society should discuss the urgent need to reform practices that contribute to false confessions and to require mandatory videotaping of all interviews and interrogations.

Discerning the Truth

A 2004 conference on police interviewing attended by the two of us illustrates the problem of bias during questioning. Joseph Buckley—president of John E. Reid and Associates (which has trained tens of thousands of law-enforcement professionals) and co-author of the manual *Criminal Interrogation and Confessions* (Aspen Publishers, 2001)—presented the influential Reid technique of interviewing and interrogation. Afterward, an audience member asked if the persuasive methods did not at times cause innocent people to confess. Buckley replied that they did not interrogate innocent people.

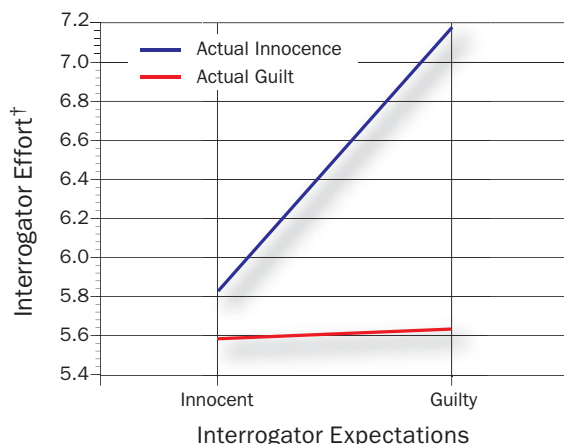
To understand the basis of this remark, it is important to know that the highly confrontational, accusatory process of interrogation is preceded by an information-gathering interview intended to determine whether the suspect is guilty or innocent. Sometimes this initial judgment is reasonably based on witnesses, informants or other ex-

COURTESY OF EVERETT COLLECTION (preceding pages)

True or False?

	Naive Students	Trained Students	Police Investigators
Total accuracy	56%	46%	50%
Confidence*	5.91	6.55	7.05

*Self-reported on a 10-point scale.



†Observer's ratings on a 10-point scale.



Training makes people more confident about their ability to distinguish truth from lies; however, it does not increase their accuracy (table). In the laboratory, interrogators tried hardest to extract a confession when they presumed guilt but the suspect was actually innocent (graph).

trinsic evidence. At other times, however, such judgments may be based on nothing more than a hunch, a clinical impression that investigators form during a preinterrogation interview.

The risk of error at this stage is clear, as in the 1986 Florida case involving Tom Sawyer, whom investigators accused of sexual assault and murder and interrogated for 16 hours, extracting a confession. His statement was later suppressed by the judge, and the charges were dropped. Sawyer had become a prime suspect because his face flushed and he appeared embarrassed during an initial interview, a reaction interpreted as a sign of deception. Investigators did not know that Sawyer was a recovering alcoholic with a social anxiety disorder that caused him to sweat profusely and blush in evaluative social situations. Many of the characteristics associated with acting "guilty" are also signs of a person under high stress.

Separating truths from lies is tricky. In fact, most experiments have shown that people perform at no better than chance levels and that training programs produce, at best, small and inconsistent improvements compared with naive control groups. In general, professional lie catchers, such as police detectives, psychiatrists, customs inspectors and polygraph examiners, exhibit accuracy rates in the 45 to 60 percent range, with a mean of 54 percent.

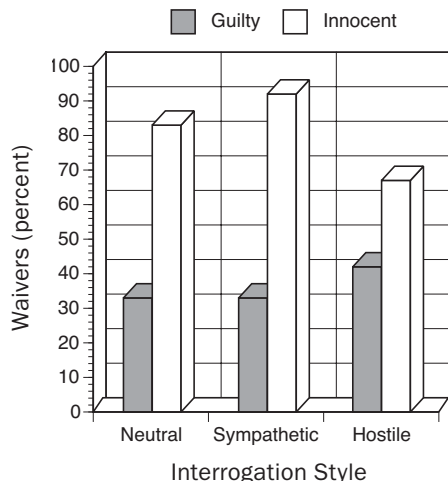
Even with those statistics, trained investigators believe they are more accurate in determining

guilt or innocence. In 2002 Christian Meissner of Florida International University and one of us (Kassin) conducted a meta-analysis to examine their performance. Across studies, investigators and educated participants, relative to naive controls, exhibited a proclivity to judge targets as deceptive—and to do so with confidence [see table above]. Expressing a particularly cynical but telling point of view, one detective is quoted as saying in a 1996 article by Richard A. Leo of the University of California at Irvine, "You can tell if a suspect is lying by whether he is moving his lips."

Protections Averted

With suspects judged deceptive from their interview behavior, the police shift into a highly confrontational process of interrogation. There is, however, an important procedural safeguard in place to protect the accused. In the landmark *Miranda v. Arizona* in 1966, the U.S. Supreme Court ruled that police must inform all suspects of their constitutional rights to silence ("You have the right to remain silent; anything you say can and will be held against you in a court of law") and to counsel ("You are entitled to consult with an attorney; if you cannot afford an attorney, one will be appointed for you"). Only if suspects waive these rights "voluntarily, knowingly and intelligently" as determined in law by consideration of "a totality of the circumstances" can the statements they produce be admitted into evidence.

Waiving Rights



Innocents are especially at risk for waiving rights to counsel and silence that were established by the U.S. Supreme Court in *Miranda*, believing they have nothing to hide (left). Yet longer exposure to questioning leaves them at greater risk for a false confession.

Miranda may not yield the protective effect for which it was designed for two reasons. First, a number of suspects—because of their youth, level of intelligence, lack of education or mental health status—do not have the capacity to understand and apply the rights they are given. Second, police use methods of presentation that elicit waivers. After observing live and videotaped police interrogations, Leo found that roughly four out of five suspects waive their rights and submit to questioning. He also observed that individuals who have no prior felony record are more likely to waive their rights than are those with a history of criminal justice “experience.” In a 2004 study by one of us (Kassin) and Rebecca Norwick of Harvard University, subjects guilty or innocent of a mock crime (stealing \$100) were confronted by a neutral, sympathetic, or hostile “Detective McCarthy” who asked if they would waive their rights and talk. Only 36 percent of guilty subjects agreed, but 81 percent of innocents waived these rights, saying later they had nothing to hide or fear [see chart above].

Interrogation Tactics

In the past, American police routinely practiced “third degree” methods of custodial interrogation—inflicting physical or mental pain and suffering to extract confessions and other types of information from crime suspects. Such tactics have mostly faded into the annals of criminal justice history, but modern police interrogations remain powerful enough to elicit confessions. At the most general level, it is clear that the two-step approach employed by Reid-trained investigators

and others—in which an interview generates a judgment of truth or deception, which in turn determines whether or not to proceed to interrogation—is inherently biased.

For innocents who are initially misjudged, one would hope that interrogators would remain open-minded and reevaluate their beliefs over the course of questioning. A warehouse of psychology research suggests, however, that once people form a belief, they selectively seek, collect and interpret new data in ways that verify their opinion. This distorting cognitive confirmation bias makes such personal convictions resistant to change, even in the face of contradictory evidence. It also contributes to the errors committed by forensic examiners whose judgments of handwriting samples, bite marks, tire marks, ballistics, fingerprints and other “scientific” observations are often corrupted by a priori expectations, a problem uncovered in many DNA exoneration cases.

In one instance in 2002, Bruce Godschalk was exonerated of two rape convictions after 15 years in prison when laboratories for both the state and the defendant found from his DNA that he was not the rapist. Yet the district attorney whose office had convicted Godschalk—even though Godschalk disavowed his initial confession—argued that the DNA tests were flawed and refused at first to release him from prison. When the district attorney was asked what foundation he had for his decision, he asserted, “I have no scientific basis. I know because I trust my detective and his tape-recorded confession. Therefore, the results must be flawed until someone proves to me otherwise.”

SOURCE: KASSIN & NORWICK, 2004 (graph); TM AND COPYRIGHT © 20TH CENTURY FOX FILM CORP. ALL RIGHTS RESERVED. COURTESY OF EVERETT COLLECTION (photograph)

The presumption of guilt also influences the way police conduct interrogations, perhaps leading them to adopt an aggressive and confrontational questioning style. Demonstrating that interrogators can condition the behavior of suspects through an automatic process of social mimicry, Lucy Akehurst and Aldert Vrij of the University of Portsmouth in England found in 1999 that increased gestures and physical activity among police officers triggered movement among interviewees—fidgeting behavior that is then seen by others as suspicious.

It is important to scrutinize the specific practices of social influence that get people to confess. Proponents of the Reid technique advise interro-

the figure is closer to 60 percent. In Japan, where few restraints are placed on police interrogations and where social norms favor confession as a response to the shame brought by transgression, more than 90 percent of suspects confess.

In so-called self-report studies, researchers ask why people confessed. In 1991 one of us (Gudjonsson) and Hannes Petursson of University Hospital in Reykjavik, Iceland, published the first work in this area carried out on Icelandic prison inmates, which was replicated in Northern Ireland and in a larger Icelandic prison population with an extended version of a 54-item self-report instrument, the Gudjonsson Confession Questionnaire.

Although most suspects confess for a combi-

(Miranda may not yield the protective effect for which it was designed.)

gators to conduct the questioning in a small, barely furnished, soundproof room. The purpose is to isolate the suspect, increasing his or her anxiety and desire to escape. To further heighten discomfort, the interrogator may seat the suspect in a hard, armless, straight-backed chair; keep light switches, thermostats and other control devices out of reach; and encroach on the suspect's personal space over the course of interrogation.

Against this physical backdrop, the Reid operational nine-step process begins when an interrogator confronts the suspect with unwavering assertions of guilt (1); develops "themes" that psychologically justify or excuse the crime (2); interrupts all efforts at denial and defense (3); overcomes the suspect's factual, moral and emotional objections (4); ensures that the passive suspect does not withdraw (5); shows sympathy and understanding and urges the suspect to cooperate (6); offers a face-saving alternative construal of the alleged guilty act (7); gets the suspect to recount the details of his or her crime (8); and converts the latter statement into a full written or oral confession (9). Conceptually, this system is designed to get suspects to incriminate themselves by increasing the anxiety associated with denial, plunging the suspect into a state of despair and then minimizing the perceived consequences of confession.

Rates of confession vary in different countries, indicating the underlying role that institutional and cultural influences play. For example, suspects detained for questioning in the U.S. confess at a rate around 42 percent, whereas in England

nation of reasons, the most critical is their belief about the strength of the evidence against them. That is why the tactic of presenting false evidence—as when police lie to suspects about an eyewitness that does not exist; fingerprints, hair or blood that has not been found; or lie detector tests they did not really fail—can lead innocent people to confess. In a 1996 laboratory experiment that illustrates the point, Kassin and Katherine L. Kiechel of Williams College falsely accused college students of crashing a desktop computer by hitting a key that they were told was off-limits. When a fellow student who was present said she had witnessed the students hit the forbidden key, the number induced to sign a confession increased by 45 percent. Also increased were the numbers who internalized a belief in their own guilt and fabricated false memories to support that belief.

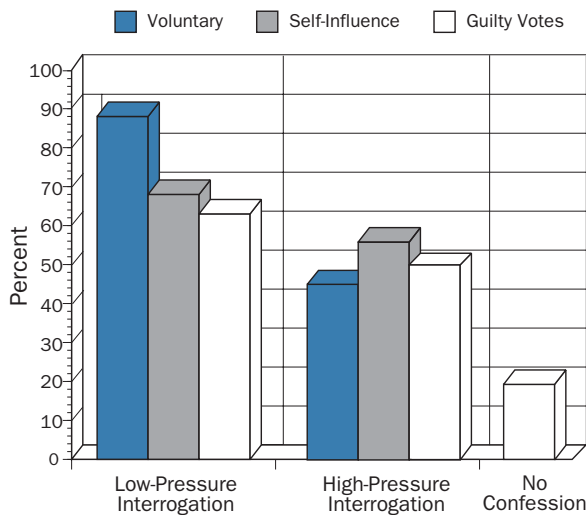
False Confessions

In 2004 Steven A. Drizin of Northwestern University School of Law and Leo analyzed 125 cases of proved false confessions in the U.S. from

(The Authors)

SAUL M. KASSIN and **GISLI H. GUDJONSSON** study the psychology of false confessions. Kassin is professor of psychology at Williams College. He has published many research articles on police interviewing, interrogations, and confessions—and the impact of this evidence on juries. Gudjonsson is professor of forensic psychology at King's College London. He pioneered work on the nature of suggestibility and has written extensively on the reliability of confessions, witness memories and other evidence.

Confessions and the Jury



The existence of a confession—true or false—predisposes juries toward reaching a guilty verdict. Mock jurors were asked whether they judged the confession to be voluntary, whether it influenced their verdict, and whether they voted for conviction.

between 1971 and 2002, the largest sample ever studied. Approximately two thirds were exonerated before the trial, and the rest came after conviction. Ninety-three percent of the false confessors were men. Overall, 81 percent occurred in murder cases, followed by rape (8 percent) and arson (3 percent). The most common bases for exoneration were that the real perpetrator was identified (74 percent) and that new scientific evidence was discovered (46 percent). The sample was disproportionately represented by persons who were young (63 percent were younger than 25; 32 percent were under 18), mentally retarded (22 percent) and diagnosed with mental illness (10 percent). Astonishingly, 30 percent of the cases contained more than one false confession to the same crime, as in the Central Park jogger case, typically indicating that one false confession was used to get others.

Recognizing that people confess in different ways and for different reasons, psychologists categorize false confessions into three groups:

Voluntary false confessions. When aviator Charles Lindbergh's baby was kidnapped in 1932, some 200 people stepped forward to confess. In the 1980s Henry Lee Lucas falsely admitted to hundreds of unsolved murders, making him the most prolific serial confessor in history. People might voluntarily give a false confession for reasons including a pathological desire for notoriety; a conscious or unconscious need to expiate feelings of guilt over prior transgressions; an inability to distinguish fact from fantasy; and a desire to aid and protect the real criminal.

Compliant false confessions. In these cases, the suspect confesses to achieve some end: to escape an aversive situation, to avoid an explicit or implied threat, or to gain a promised or implied reward. In *Brown v. Mississippi* in 1936, for example, three black tenant farmers admitted to murder after they were whipped with a steel-studded leather belt. And in the Central Park jogger case, each boy said he had confessed despite innocence because he was stressed and expected to go home if he cooperated.

Internalized false confessions. During interrogation, some suspects—particularly those who are young, tired, confused, suggestible and exposed to false information—come to believe that they committed the crime in question, even though they did not. In a classic case, 18-year-old Peter Reilly of Falls Village, Conn., returned home one night to find that his mother had been murdered. Reilly immediately called the police but was suspected of matricide. After gaining Reilly's trust, the police told him that he failed a lie detector test (which was not true), and which indicated that he was guilty even though he had no conscious memory of the event.

After hours of interrogation, the audiotape reveals that Reilly underwent a chilling transformation from denial to confusion, self-doubt, conversion ("Well, it really looks like I did it") and finally a full confession ("I remember slashing once at my mother's throat with a straight razor I used for model airplanes.... I also remember jumping on my mother's legs"). Two years later independent evidence revealed that Reilly

SOURCE: KASSIN & SUKEL, 1997 (graph); COURTESY OF EVERETT COLLECTION (photograph)

could not have possibly committed the murder.

Trial jurors, like others in the criminal justice system who precede them, can be overly influenced by confessions. Archival analyses of actual cases containing confessions later proved false tell a disturbing tale. In these cases, the jury conviction rates ranged from 73 percent (as found by Richard Ofshe of the University of California at Berkeley and Leo in 1998) to 81 percent (as found by Drizin and Leo in 2004)—about the same as cases in which the defendants had made true confessions.

colleagues found that such covert assurances can contribute to false confessions.

The Need for Reforms

To assess any given confession accurately, police, judges, lawyers and juries should have access to a videotaped record of the interrogation that produced it. In Great Britain, PACE mandated that all sessions be taped. In the U.S., four states—Minnesota, Alaska, Illinois and Maine—have mandatory videotaping, although the practice is

(Trial jurors, like others in the criminal justice system, can be **overly influenced** by confessions.)

In light of such findings, the time is ripe for law-enforcement professionals, policymakers and the courts to reevaluate current methods of interrogation. Although more research is needed, certain practices clearly pose a risk to the innocent. One such factor concerns time in custody and interrogation. The 2004 study by Drizin and Leo found that in proved false confession cases, the interrogations lasted for an average of 16.3 hours. In the Central Park case, the five boys were in custody for 14 to 30 hours by the time they confessed. Following the Police and Criminal Evidence Act of 1986 (PACE) guidelines implemented in England and Wales, policy discussions should begin with a proposal for the imposition of time limits for detention and interrogation or at least flexible guidelines, as well as periodic breaks for rest and meals.

A second problem concerns the tactic of lying to suspects about the evidence. Research shows that people capitulate when they believe that the authorities have strong evidence against them. The practice of confronting suspects with real evidence, or even their own inconsistent statements, should increase the reliability of the confessions ultimately elicited. When police misrepresent the evidence, however, innocent suspects come to feel as trapped as the perpetrators—which increases the risk of false confession.

A third matter revolves around the use of minimization, as when police suggest to a suspect that the conduct in question was provoked, an accident or otherwise morally justified. Such tactics lead people to infer leniency in sentencing on confession, as if explicit promises had been made. In a study that is now in press, Melissa Russano of Roger Williams University and her

often found elsewhere on a voluntary basis. Videotaping deters interrogators from using the most aggressive, psychologically coercive methods. It also will block frivolous defense claims of coercion where none existed. And it provides an objective and accurate record of all that transpired, avoiding disputes about how the confession came about.

A 1993 National Institute of Justice study revealed that many U.S. police departments already have videotaped interrogations—and the vast majority found the practice useful. More recently, in 2004, Thomas P. Sullivan of the law firm Jenner & Block interviewed officials from 238 police and sheriff's departments in 38 states who made such recordings voluntarily and found that they enthusiastically favored the practice, which increases accountability, provides an instant replay of the suspect's statement that reveals information initially overlooked and reduces the amount of time spent in court defending their interrogation conduct. As a counter to the most common criticisms, those interviewed found that videotaping is not costly and does not inhibit suspects from talking to police.

Such reforms are sorely needed. Only then can society trust the process of interrogation and the confessions that it produces—and help to promote justice for all.

(Further Reading)

- ◆ **The Psychology of Interrogations and Confessions: A Handbook.** Gisli Gudjonsson. John Wiley & Sons, 2003.
- ◆ **The Psychology of Confessions: A Review of the Literature and Issues.** Saul M. Kassin and Gisli H. Gudjonsson in *Psychological Science in the Public Interest*, Vol. 5, No. 2; November 2004. More information is available at www.psychologicalscience.org/journals/
- ◆ More on wrongful convictions is available at the Innocence Project Web site: www.innocenceproject.org

For this
mountain-
climbing
neuroscientist,
explaining
consciousness
is the ultimate
extreme sport

The Quest of Christof Koch

By David Dobbs

Intensity helps Koch (*opposite page*) surmount mental challenges and scale big walls, such as Half Dome, 2,000 feet above the Yosemite National Park floor (*right*).



Brain scientists will tell you that the greatest problem facing human biology, and perhaps all of science, is cracking the code of consciousness. It means solving the long-intractable brain-mind conundrum: How does our material brain—the most complex physical system known—produce our immaterial but vital sense of awareness? Neuroscientists and philosophers argue fiercely about how to solve the riddle and whether it is even solvable. Some say consciousness is illusory. (Try to counter that one—a real headache.) Others say consciousness exists but at too complex a level for humans to fathom, like quantum mechanics is for monkeys. Still others believe consciousness will yield its secrets only when we discover new physical brain laws that could reveal its creation.

Christof Koch rejects all this skepticism. As one of the world's leaders in the field, the California Institute of Technology neuroscientist believes that consciousness is distinctly physical, that it can be described by exist-

COURTESY OF CHRISTOF KOCH (*left*); CATHERINE LEDNER (*opposite page*)



ing neurological theories, and that he is on the way to figuring it out. He has some invaluable help in collaborators such as Tomaso A. Poggio, the neural-networks and artificial-intelligence guru at the Massachusetts Institute of Technology, and some lasting inspiration instilled by his close friend and longtime collaborator, the late Francis Crick, who with James D. Watson won the Nobel Prize for discovering the double-helix structure of DNA. The key to finding an answer, Koch says, is to trace the activity of neurons—the “neural correlates”—of the simplest type of con-



At 48, Koch runs marathons and scales huge cliffs. For his midlife crisis, he says, “My wife got a sports car. I got a new kitchen. But it wasn’t enough. So I climb.”

sciousness, which is the awareness of something we see. “Some of my colleagues think I’m naive,” Koch remarks, “that this rather narrow focus won’t reveal the workings. And they might be right. But as a scientist, I think this is the most likely way to solve this problem.”

Koch draws this faith in part from history, where biology’s Big Problems have so often been unraveled with a focus on simple systems. Austrian monk Gregor Mendel discovered the mechanics of heredity by splicing pea plants; British naturalist Charles Darwin saw the operation of natural selection in barnacles, birds and dog breeding. More recently, neuroscientist Eric Kandel won a Nobel Prize in 2000 for revealing the

microbiology of memory by studying sea slugs. Koch believes that defining the mechanism behind the simplest kind of visual consciousness could similarly open a door to understanding higher levels of consciousness. He is buoyed by the highly supportive environment at Caltech, where he heads the Computation and Neural Systems program; by the efforts of the 20 people in his lab; and by the stimulation he gets from sharing ideas with many colleagues, from Kandel to France’s eminent neuroscientist Stanislas Dehaene of INSERM, who think he is on the right track.

Another Koch admirer is neurologist and writer Oliver Sacks, who has known Koch since Crick introduced them in the late 1990s. Sacks, who admits a bias stemming from his own fascination with visual consciousness, thinks Koch’s inquiry is “both the most fascinating and the most promising approach” to the consciousness problem. “There’s a brilliant directness to it,” Sacks says. “And with his energy and his mental quickness—well, you have to give the man an excellent chance.”

Yeee-Hooo!

Koch’s energy is indeed striking. He dyes his hair orange and purple and wears clothes in the same hues, all of which seem natural extensions of an incandescent intellect and a physical restlessness so profound that in his 40s—he is 48 now—he took up running marathons and scaling huge cliffs. He rock-climbs as often as possible at the towering slabs in Joshua Tree National Park, two hours east of Caltech’s Pasadena, Calif., campus, and he has scaled big walls in Yosemite National Park, including the 3,000-foot face of El Capitan. He talks fast and adds lots of hand gestures.

The son of German diplomats, Koch was born in Kansas City, Mo., raised in Germany, Amsterdam and Morocco, and sounds like a brainy Arnold Schwarzenegger. When referring to consciousness, he often rubs the top of his multicolored head with his fingertips, his long arm bent high above his six-foot four-inch frame. He always seems hurried but fully engaged. In studying consciousness, he seems to have found his ideal subject. He loves it intellectually, as the most absorbing and fascinating scientific problem imaginable. And he loves consciousness phenomenally, as something to experience.

This became evident to me when I first heard his cowboy yell, near the end of a long day in New York City. He had delivered two lectures to

JESSICA BOYATT, COURTESY OF CHRISTOF KOCH

philosophers at New York University, made a round of visits to neuroscience labs there, then skipped dinner to give a riveting talk at the New York Academy of Sciences at its mansion off Fifth Avenue, after which he answered questions from the bedazzled audience for two hours. Finally, he escaped, and we took a cab ride downtown to Pastis, a fashionable West Village bistro. We pushed our way to the bar and ordered ales. The beer, along with the vibrant room full of chic people and the prospect of dinner, so pleased him

from the Salk Institute), the two began a conversation about consciousness that quickly blossomed into an ongoing collaboration involving countless phone calls, visits, dinners and many joint publications.

It was a rich partnership in which likenesses transcended differences. Crick was a very distinguished 70 then, an ever urbane and distinctly British presence. Koch, 40 years younger, seemed exceedingly flamboyant. But they shared a quickness of mind and intellectual irreverence, an ap-

(Koch believes that explaining visual consciousness could **open a door** to all of higher consciousness.)

that he unleashed a hair-raising hoot: “Yeee-Hooo!” I looked around, but no one in the boisterous crowd had minded. Smiling, Koch held out his beer to clink glasses. “Wonderful!” he shouted, gesturing at the happy scene around him. “I love it!”

When Koch started investigating awareness—in his late 20s, freshly arrived and then untenured at Caltech—he was told repeatedly that pursuing a theory of consciousness was professional suicide. Throwing down such a gauntlet may well have motivated Koch even more. Science has changed since then, too, as an explosion in neuroscience, particularly the ability to image the physical bases of various mental states, has made the problem more approachable. Every month researchers find new links in the obscure chain between sense and sensibility. Most investigators think someone will pull the whole thing together in the next 25 years, possibly in the next decade. Whoever does will very likely win a Nobel Prize.

Koch was permanently drawn into consciousness research through work with Crick. After co-discovering the structure of DNA in 1953, Crick worked another two decades in England on microbiology and embryology before accepting an offer in 1976 to join the Salk Institute for Biological Studies in La Jolla, Calif. Soon after his arrival he became interested in the consciousness problem, seeing it as the great remaining unexplored question in biology. He and Koch met three years later at the Max Planck Institute for Biological Cybernetics in Tübingen, Germany, where Koch was finishing his Ph.D. in neural processing. In 1986, when Koch joined the Caltech faculty (which put him two hours away

from the Salk Institute), the two began a conversation about consciousness that quickly blossomed into an ongoing collaboration involving countless phone calls, visits, dinners and many joint publications.

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preciation of each other’s wit and warmth, and the conviction that disciplined, results-oriented science could solve this nebulous problem. Crick died last summer. Koch misses him constantly. “I so often catch myself, after I hear about a new experiment or a new idea, thinking that this is what Francis thrived on,” he says. “And that I would have called him to tell him about it and he would chide me gently or get intrigued and ask lots of questions. More than any scientist I’ve ever known, Francis could focus on the most important points but be willing to abandon an idea if something suggested it was wrong. So few can do that. He always had a sure sense of where to go.” Koch and Crick agreed early on to focus on visual consciousness, and Koch retains that focus today. He is not after the higher-order consciousness that allows us to dream, imagine a chain of events or think our way through abstract problems. Rather he seeks the collections of neurons and physiological processes that produce the awareness of a particular sight. It is a simple agenda of enormous complexity—a clean entrance, Koch hopes, into the labyrinthine workings of consciousness. Being aware of seeing something requires the coordinated work of multiple brain regions. Say you are walking along the edge of a park, admiring a building across the street, when a bird enters your field of view. Your retina shoots an impulse down the optic nerve

(The Author)

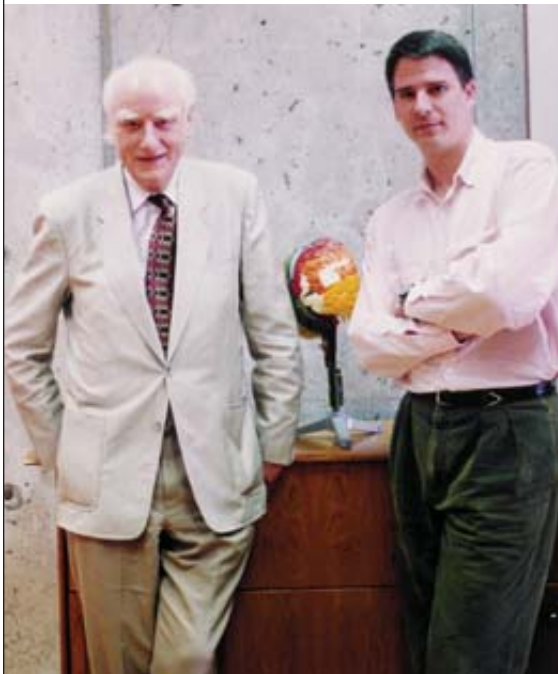
DAVID DOBBS is author of *Reef Madness: Charles Darwin, Alexander Agassiz, and the Meaning of Coral* (Pantheon Books, 2005). His writing can be found at www.daviddobbs.net

(Koch is so delighted with the gift **he punches me** in the arm and lets out another cowboy yell.)

DNA pioneer Francis Crick (left), Koch's research partner, died last year. "I so often catch myself, after hearing a new idea, thinking that I would have called him about it and he would chide me gently or get intrigued and ask lots of questions."

and through the thalamus (near the center of your head), which relays the sensory input to cortical processing areas. The impulses then move on to the primary visual cortex, called V1, in the back of your brain. But you are still not aware of the bird.

That happens, Koch asserts, only through a competition between a temporary coalition of neurons associated with the bird and other coali-



tions associated with other objects vying for your visual attention—the building you were admiring, the red car approaching up the street alongside the park. Each coalition engages, by Koch's estimate, not just the thalamus and V1 but other parts of the visual cortex at the brain's rear, as well as key cortical columns—bundles of nerves that run vertically through the cortex's six layers—in the medial, temporal and frontal lobes. It's a winner-take-all contest. If the bird is striking enough or you favor birds, its neuronal coalition wins out, and it enters and dominates your visual consciousness: you stop admiring the building and watch the bird. *[To experience this neuronal competition, see box on opposite page.]*

Why would we need such awareness? To serve as a sort of "executive summary" of reality

that allows quick, effective action, Koch says. He speculates that such consciousness developed at some point in mammals because an explicit attentional awareness conferred an evolutionary advantage in finding food, spotting and evading predators, and (later) negotiating social interactions. Although we have subsequently evolved higher conscious functions for language, long-term planning and abstract thought, this simple visual awareness came first and is likely to yield most readily to investigation.

The Ultimate Climb

Koch and Crick's strategy arose from careful study and imaginative contemplation of modern neuroscience. In the past decade, the larger neuroscience and philosophy-of-mind community has come to consider this strategy one of the most promising empirical approaches to unveiling consciousness. Koch must now try to fulfill that promise. Because he is looking at the big picture (if in a concentrated way), he must track, evaluate and account for every major finding in neuroscience. Most of his own research focuses on identifying particular nodes and links that form the neural pathways that filter and create particular visual percepts (the mental result of perceiving, distinct from the act of perceiving). His work often involves cutting-edge tools such as brain scans, electroencephalography and neuronal probes to study monkeys or people as they view objects, faces or perception tricks.

As these investigations tie specific conscious perceptions to particular neuronal activity, Koch must find ways to test those correlations by turning on and off the suspected neurons in animals and, eventually, humans. Such "switching" methods currently involve electrical stimulation or nerve freezing; future techniques may include prodding genes to temporarily halt transmissions from targeted neurons. Koch and others have made remarkable progress in all these areas in just the past five years. But this is unpredictable work, and the possibility of following the wrong trail haunts them all.

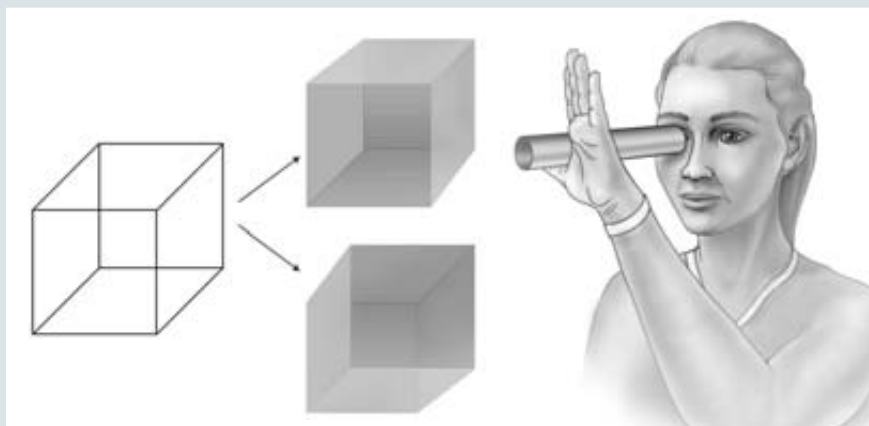
Koch appears energized by the challenge. Actually he seems energized by everything. At Patis he easily lasts till midnight, fueled by sea bass and a bottle of Beaujolais until, postdessert, with a glass of Armagnac at hand, he relates how

COURTESY OF CHRISTOF KOCH

Seeing Your Visual Consciousness

Much of Christof Koch's work involves analyzing the neuronal activity of monkeys or humans who must confront visual puzzles and anomalies. Among Koch's favorites are bistable illusions—drawings that can be “seen” in two incompatible ways, such as the Necker cube (*below, left*). Another is binocular rivalry (*right*), in which each eye is presented with a different image; the mind cannot render both images at once, so it alternates between them. These exercises illustrate the winner-take-all competition among groups, or coalitions, of neurons that process the two possible images. By placing tiny probes in monkeys' brains and doing scans on humans viewing these illusions, Koch hopes to trace how the mind decides which image to bring to the subject's consciousness and therefore how visual consciousness is formed. That, in turn, could open up a window into how all of consciousness arises.

You can provoke—and observe—neuronal competition in your own brain by viewing the Necker cube. The cube on the left can be seen in one of two different ways (*shown by shaded options*); if you look at the open cube, you will see the two different visual interpretations, either switching through your own will or, when one coalition of neurons tires, allowing the other view to take over.



You can also experience binocular rivalry by rolling up a sheet of paper into a tube and looking through it, as shown in the second illustration. Hold the tube against your right eye, with your left hand in front of your left eye, as shown, and look straight ahead with both eyes. You will see a hole in your left hand. Now point the tube at a dark background and hold it steady, allowing your eyes to adjust (instead of deliberately peering through the tube); the hole

in the back of your hand may suddenly fill in (this could take up to a minute). This view may be fleeting, but it will most likely alternate with the sight of the hole in your hand and with whatever background object you are pointing the tube at. You are observing the ongoing competition among your neuronal coalitions, which vie with one another for dominance as the perceived image changes. —D.D.

crushed he was when his kids left home for college a couple of years before.

“Oh it was terrible!” he says laughing, talking as fast as ever. (Koch does not use commas.) “It provoked the classic midlife crisis in which of course I am supposed to get a sports car and drive off with a student. But I didn’t. My wife got a sports car. A Porsche. I got a new kitchen—new cabinets, range, black marble counters.” He waves his hands along the appropriate planes to put cabinets and counters in place. “But it wasn’t enough. The house is too quiet. Even with the three dogs. So I climb.”

A few minutes later we exit into a snowstorm. The wind smacks wet flakes into our faces. We are getting ready to part when I remember I have brought him a gift, a collection of mountaineering accounts by the British climbers Peter Boardman and Joe Tasker. He wants to see it immediately, so we huddle in a doorway and look at photographs

of Boardman and Tasker in the Himalayas, exposed on the planet’s most austere heights: Changabang, Kanchenjunga, Gaurisankar.

“They’re dead now,” I tell him, “lost on Everest in 1982.”

“But still,” he says. He is entranced, shaking his head. “Look at this.” It is Boardman and Tasker ascending the knife-edge ridge of Gaurisankar—an insane climb they somehow made and lived through. “I mean, to do this—can you imagine? What a thing! I love it.” Koch is so delighted he punches me in the arm and lets out another cowboy yell. Then he heads off through the snow.

(Further Reading)

- ◆ **The Quest for Consciousness.** Christof Koch. Roberts & Co., 2003.
- ◆ **In the River of Consciousness.** Oliver Sacks in *New York Review of Books*; January 15, 2004.
- ◆ The Koch laboratory Web site is www.klab.caltech.edu

A man is submerged in water, looking directly at the camera. He is holding a US dollar bill in his right hand, which is extended towards the viewer. The water is dark blue with many small bubbles and light reflections. The man has a neutral expression and is wearing a dark blue button-down shirt. The word "SWEET" is printed in a white, serif font in the upper right area of the image.

SWEET



DREAMS ARE MADE OF THIS

What are dreams? Why do we have them? The answers are as intriguing as dreams themselves

By Gerhard Klösch and Ulrich Kraft

In his time, Artemidorus Daldianus was a highly regarded man. He was a dream doctor, and in the second century A.D. his fellow Greeks considered dreams to be encoded messages from the gods. Deciphering them required an expert, with Artemidorus chief among them.

Artemidorus declared that all dreams were not created equal, however. If the nocturnal visions could be explained from past events in the sleeper's life, the good doctor wrote them off as meaningless constructions of the individual's experiences and mental orientation; these dreams were not secrets of the gods. Artemidorus himself would never have imagined that, with this idea, he had anticipated a core debate that would arise some 1,700 years later.

The physician who sparked that debate was none other than Sigmund Freud. According to his monumental 1899 work, *The Interpretation of Dreams*, our nighttime hallucinations are activated by subconscious wishes that can burst forth from behind the protective veil

of sleep. Freud's contention was just that, however—a hypothesis, one that neurologists of the day could never prove despite a flurry of scientific investigation. Freud lacked the answer to the ancient question, “What does the brain do when we enter the dreamworld?” And it frustrated him. He openly wished for neurological evidence, worked at it himself and even said that such information would likely supersede his psychological theories about dreams. But he lacked the science and tools needed to find it.

the same people were woken during other sleep phases, however, only 5 to 10 percent reported dreams. Neurologists celebrated the discovery: REM sleep, the high-frequency pattern of brain waves and the reduced muscle tone were objective manifestations of the subjective experience of dreams. The excitement was so great that dream researchers dismissed the rest of the sleep cycle as meaningless “non-REM,” an assumption that would later prove premature.

A plethora of experiments about the biochem-

（ Emotionally loaded dreams fill REM sleep. Subdued visions arise during non-REM sleep. ）

Today we have better tools, and modern explanations of dreaming are being turned on their heads, in some cases leading back to age-old theories. But as scientists try to pin down what causes dreams and what they mean, if anything, one lesson has clearly emerged: dreams play a vital role in memory and learning, and it is too early to give up on the proposition that they provide a window into our true emotions as well.

The REM Revolution

As Freud's stature grew in the early 1900s, psychologists the world over strongly embraced his theory of dreams. It was not until the 1950s that we reached the next turning point in our understanding. Nathaniel Kleitman of the University of Chicago and a student assistant in his sleep laboratory, Eugene Aserinsky, began to record the eye movements of sleeping children. Kleitman hoped to find an indicator for when the wee ones would awaken. In 1953 the duo found that during overnight sleep, test subjects went through four to six periods of eye twitching, each lasting from 10 to 50 minutes. The pattern held in adults, too. The scientists named this phase rapid eye movement (REM) sleep.

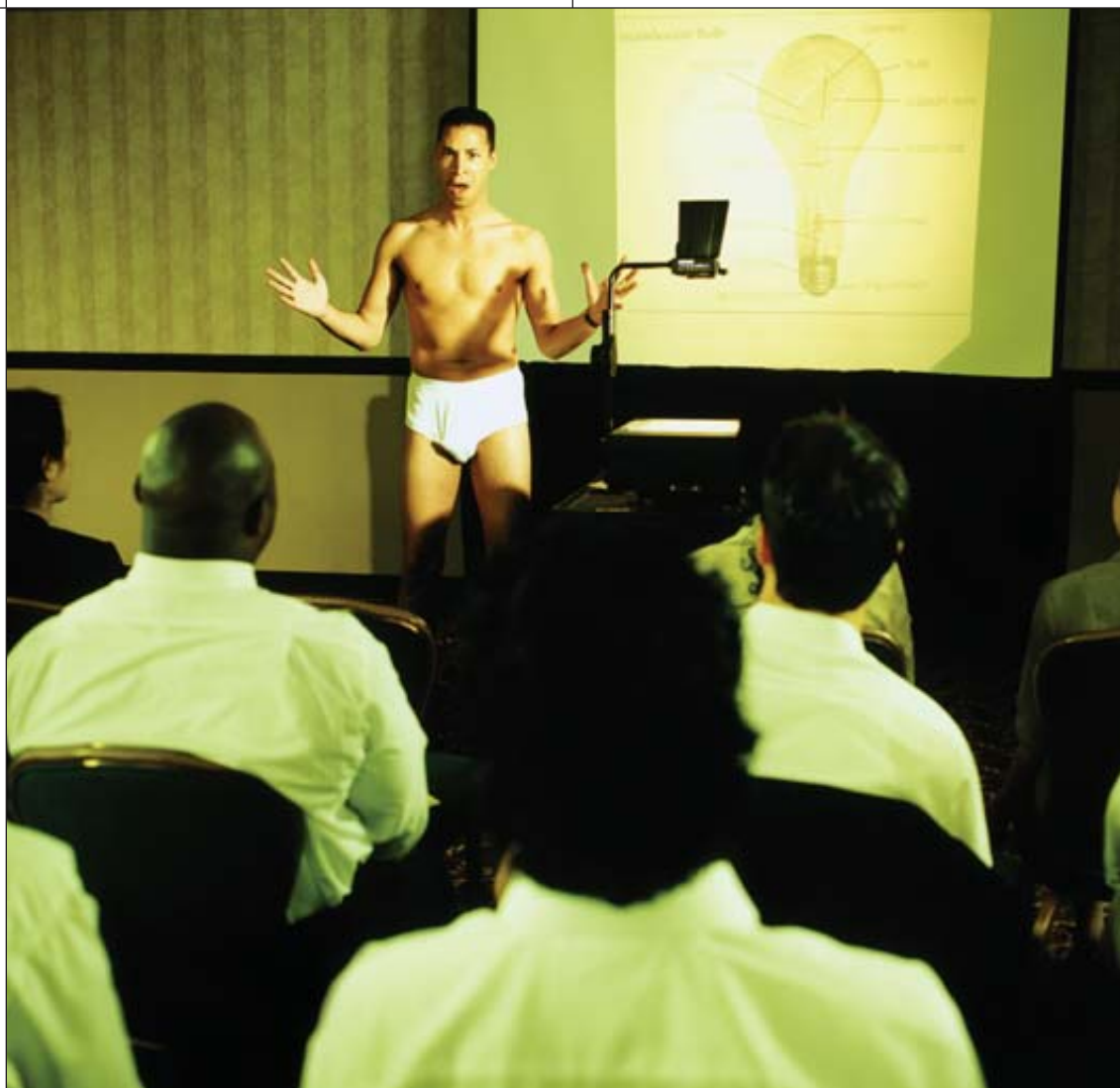
Kleitman was even more amazed when he looked at the sleepers' brain waves, recorded by electroencephalograms (EEGs). The brain was extremely active during the REM phase; neurons fired about as much as they did when the subjects were awake. Yet their muscles were practically flaccid during REM sleep. Kleitman and Aserinsky wondered what all the activity was about. So they began waking their subjects during the high point of REM sleep and asking them if they had been dreaming. From 80 to 95 percent said yes. If

ical mechanisms of REM sleep boosted scientific euphoria for two decades. Proof that REM sleep occurred in almost all mammals—mammals that in labs could be much more comprehensively investigated than humans—added fuel to the fire. In 1962 neurophysiologist Michel Juvet of the University of Lyon in France discovered that in cats, a relatively small bundle of nerve cells in the brain stem known as the pons was always active when muscles were relaxed during sleep. If he disturbed the pons, muscles stiffened and quick eye movements did not occur.

Juvet later implanted electrodes into cats' brains and managed to trigger REM phases by electrically stimulating the pons. He also found, to his surprise, that higher-order brain regions had no function in REM whatsoever. Even animals in which all nerve connections from the pons to the cerebral cortex had been severed fell into REM sleep. The REM center appeared to reside in the pons, which lies in the brain stem, an old, primitive brain region that bears responsibility for basic functions such as breathing and heartbeat.

Looking for Work

But how did the pons control REM and non-REM states? Did dreams have nothing to do with the brain's emotional centers? If not, where did dreams' fantastic visions and delightful story lines, their chase scenes and terrors, their sexual exploits and tensions, come from? In the 1970s, building on Juvet's results and their own extensive work in sleep labs, J. Allan Hobson and Robert W. McCarley of Harvard Medical School presented two complementary theories: the reciprocal-interaction and the activation-synthesis models. According to the former, REM sleep and



ANXIETY
Do dreams lay bare hidden apprehensions or simply reflect known worries?

the dreams related to it are turned on and off by a tug-of-war between special networks of neurons in the pons.

The neurophysiologists determined that so-called REM-on neurons used the neurotransmitter (a messenger chemical) acetylcholine to send impulses to various brain regions, triggering arousal. Acetylcholine caused neurons to fire not only in the pons but also in parts of the cortex and in the limbic system, the emotional center of the brain. According to the researchers' activation-synthesis model, dream images arise randomly from neurons that fire in these various regions. The sleeping brain tries to do with these signals exactly what it does in its waking state with sensory inputs: make sense of them.

Hobson and McCarley said that dreams are the vain attempt of the brain to concoct coherent story lines that link random signals. As part of this effort, the frontal cortex connects the senseless impulses of the pons with feelings, sensory

impressions and experiences from memory, composing a narrative that fits the stimuli—a narrative the sleeper experiences as a dream.

After 50 minutes at most, the REM-off nerve cells bring this exercise to an end. They release the neurotransmitters norepinephrine and serotonin, both of which counter the effect of acetylcholine. The sleeper stops dreaming. For the average person the entire cycle repeats every 90 minutes or so throughout the night.

The activation-synthesis model made Freud's basic assumptions untenable. Psychological phenomena such as emotionality, motivation or subconscious desires did not prompt dreams. Self-regulating biochemical feedback loops in the primitive brain did. When Hobson and McCarley introduced their heretical model in the December 1977 issue of the *American Journal of Psychiatry*, they caused an uproar among psychologists. Stating that dreams were nothing more than a by-product of brain chemistry was seen as a vehe-

FREE FALL
Are you plummeting helplessly toward disaster or feeling freed from daily bonds?



ment attack on Freud and therefore on all of psychoanalysis, widely held as the best way to “cure” people with all degrees of mental illness. The renowned journal received more letters about that article than any that had come before it—most of them expressing outrage. Hobson would later acknowledge that he and McCarley had invented fire when light might have been more useful, but until the fire was lit the scientific community had grossly neglected the brain chemistry that was undeniably fundamental to dreaming.

Indeed, the activation-synthesis model spawned a wide body of research into the neurological stuff that dreams are made of, and the model was confirmed again and again through experimentation. For example, test subjects who were injected with acetylcholine shortly after falling asleep progressed into dream sleep much faster than usual. And administering an acetylcholine inhibitor delayed REM sleep and dreams.

Lobbing a Grenade

But had Hobson and McCarley completely solved the riddle? Dream researcher W. David Foulkes, then at the University of Chicago, decided to find out by systematically waking his subjects during different sleep phases; his results showed that equating REM sleep with dreaming and non-REM sleep with a dreamless state was too simplistic. Although only 5 to 10 percent of sleepers who were woken during a non-REM

phase reported dreams, the picture changed drastically when Foulkes reformulated the standard question of sleep research from “Were you dreaming just now?” to “What was going through your head just now?” Suddenly 70 percent described dreamlike impressions during non-REM periods.

Similar experiments into the 1990s showed that REM sleep was not even necessarily the most dream-intensive segment of overnight rest. The phases of falling asleep in late evening and the brief interval shortly before waking in the morning were especially rich in dreams. In addition, it seemed that non-REM dreams were relatively short and rationally constructed in terms of facts and logic, whereas REM dreams were more visual, emotional and detailed.

All these findings made it appear unlikely that REM sleep exclusively drives dreams. Dreaming seemed to be more of a continuous process, not one sequestered within certain sleep phases. This new view raised doubt that the pons in the brain stem was the exclusive source of our dream visions. Scientists who searched back into medical literature found an unusual case that supported their suspicion. In 1982 a man had arrived at the sleep laboratory of Peretz Lavie at the Technion-Israel Institute of Technology. The reason: since he had incurred a head injury during a grenade explosion, he had suffered regularly from terrible nightmares. The sleep doctors wired his brain to

MATTIAS CLAMER Getty Images

an EEG and the next morning were astonished: the man had not gone into a single REM episode the entire night. That omission seemed impossible.

Lavie immediately resorted to computer imaging, which revealed that a small grenade splinter had bored into the man's pons and had destroyed exactly the area that supposedly controlled REM sleep and the dream trigger. So a complete lack of REM sleep made sense. But how, then, could the man be regularly tormented with nightmares? Did dreaming and the control of REM sleep rely on separate mechanisms?

Mark Solms of the University of Cape Town in South Africa became one of the first experts to say yes. For years the neuroscientist had sought cases of patients whose brain stems had been damaged by accidents or disease. If dreaming and

The second area of damage that Solms found could cause a complete loss of dreams was in the occipitotemporo-parietal cortex, behind and above the ears. This region is responsible for processing perceptions and abstract thinking. Its role in dreaming remains unclear.

What Solms's research did make clear, though, is that dreaming often takes place independently of REM sleep and of REM's generators in the pons. And it seems that only damage to the frontal lobes of the higher cortex causes dreams to disappear. Damage to lower-level information-processing areas, such as the visual system, may affect only parts of dream images, such as their visual quality. Solms had inverted the modern model of dreams. During sleep, according to Solms, higher-level areas of the cortex

(Dreams may etch daytime learning into memory and erase informational refuse.)

REM sleep were connected anatomically, a defect in this region would cripple both phenomena. After Lavie's find, Solms and others looked harder and compiled 26 cases of patients who no longer experienced REM sleep because of damage to the pons. Only one patient reported a total loss of dreams, however. All the others experienced nocturnal interludes without REM sleep. At the same time, Solms's group uncovered more than 100 cases of people who said they never dreamed, even though their pons was intact and they slept through completely normal REM phases.

Finally, Independence

Those 100-plus people did, however, have lesions in other brain regions. Solms identified two areas in which damage could cause complete loss of the dream experience, and those areas had no anatomical or functional connection to the pons. The first is the so-called white matter of the frontal lobes, above the eye sockets. Impulses arrive there from various parts of the brain with the aid of the neurotransmitter dopamine, which influences motivation and drive.

Solms noted from clinical drug trial results that medications reducing the brain's dopamine level also decreased dream activity. And dopamine enhancers, such as L-dopa used in treating Parkinson's patients, caused more frequent and intense dreams. But neither regimen affected the frequency or length of REM sleep.

generate dream images that then waft through the memory and emotion centers before they are finally perceived by our sleeping senses.

Was Freud Right?

By 2002 or so it seemed that neuroscientists, psychiatrists and psychologists were falling into one of two camps led by Solms and by Hobson. Public debate became heated, including in the pages of *Scientific American* magazine. Although Solms agreed that the primitive pons stimulated REM sleep, he also believed the origin of dream content lay in the highest-level brain regions, which Hobson characterized as passive recipients of meaningless signals from the brain stem. Solms's view allowed that dream content could be shaped by hidden emotions and motives or forgotten memories, and legions of Freudians—psychoanalysts who based their practices on Freud-like theories—came running into the fold.

This time the critical volleys came from neuroscientists. They claimed that Solms had developed his model from the beginning under the premise of confirming Freud's dream theory and that he was simply looking for the brain regions

(The Authors)

GERHARD KLÖSCH is a psychologist and sleep researcher in the department of clinical neurology at the University of Vienna. ULRICH KRAFT is an editor at *Gehirn & Geist*.

that best fit that preconceived notion. Hobson challenged Solms's theory with several arguments, one of them the plain fact that we almost always forget our dreams by morning. If dreams were really problem-solving or processing functions of the brain, then we should easily remember them when we wake up. Neither researcher, though, could produce unambiguous neurological proof of his claim.

Modern imaging techniques, however, had already begun to influence the stalemate. In 1997 neuroscientist Allen R. Braun of the National Institutes of Health had succeeded in taking positron-emission tomography (PET) pictures of the human brain during REM sleep. Braun's images demonstrated that in REM sleep, the regions that process sensory information are less active than they are in the waking state. This made sense because the slumbering brain is receiving no signals from the senses. But the frontal cortex, responsible for integrating information from other brain areas, also remained relatively calm during the REM phases—a contradiction to Solms's theory that dream content originates there. The limbic system, in particular the amygdala, was very active but only during REM rather than non-REM dreams. That did not directly support Solms or Hobson, but it did explain the differing dream content reported by test subjects in these two

dream states: emotionally loaded experiences during REM sleep and emotionally subdued experiences during non-REM sleep.

To Sleep, Perchance to Learn

The debate over exactly how dreams are initiated and sustained still roars today. In the meantime, researchers are trying to answer the related question of why we dream at all. Recent imaging studies show that during REM phases the hippocampus, a brain region key to creating memories, is extremely active. This insight lends strong evidence to a notion Hobson and others had raised—that dreams help the brain lay down memories and hardwire new information. Perhaps, they posulated, dreams were a tool the sleeping brain used to link events from the prior day's milieu to what the brain had already stored and to etch these new wrinkles into long-term memory. Each night, dreaming would help the brain update its lifelong store of memories and learning. Different experiments have demonstrated that animals as well as humans retain new knowledge better after an undisturbed nap or night of sleep. If researchers prevent test subjects from sleeping during REM, they do not retain new information as well as those who are allowed to sleep.

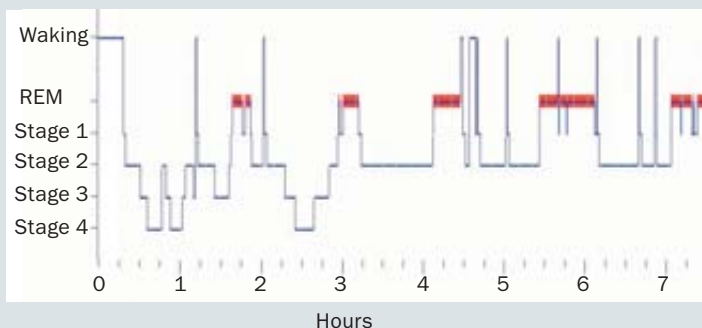
REM sleep appears to be especially important for strengthening visual and motor skills. If someone practices a new set of tennis strokes on a given day, for example, the REM segment of his or her sleep will increase dramatically that night. If one wakes this person repeatedly during REM phases, the retention is hindered—more so than if only non-REM sleep is disturbed.

A mounting number of experiments show that during sleep, the brain makes new connections between neurons, especially in regions that were active in learning during the day. Neurologist Pierre Maquet of the University of Liège in Belgium has demonstrated that this connection occurs most aggressively during REM sleep. And yet other studies indicate that the retentiveness of people who have taken REM-suppressing medications for years is not affected. Patients who do not enter REM phases because of brain damage do not seem to lack in learning ability either.

The famous co-discoverer of DNA who also became renowned for his work in neuroscience, the late Francis Crick of the Salk Institute for Biological Studies in San Diego, and molecular biologist Graeme Mitchison of the University of Cambridge have maintained that we actually dream to forget. According to their theory, dream sleep is a self-cleansing program. Unencumbered

REM Zone

Most adults have a similar sleep cycle that recurs every 90 minutes or so, from four to six times a night. The graph below for one test subject is typical. The individual falls asleep (stage 1) and reaches stage 2 soon after. In another 20 minutes or so deep sleep begins (stages 3 and 4). A REM phase ends the first sleep cycle. In the course of the night the dream-rich REM periods lengthen in duration, while deep-sleep stages shorten. For optimal physical and mental recuperation, it is most important that sleep during the first third of the night is undisturbed. Most people also wake up a number of times without realizing it.



PANIC
Is someone
looking to run
you down,
or are you just
having trouble
staying ahead?



by the constantly flowing signals of the waking state, the brain uses the calm of the night to free the system from informational refuse. Superfluous and disturbing images, memories and associations are brought up in dreams, checked for value, then erased from the cortex.

Crick said that this “reverse learning” prevents the neuronal network from being flooded with data, making it possible for us to once again have an orderly commerce with memories the next morning. Dreaming as unlearning also explains why we are so poor at remembering our nocturnal images. And yet Crick himself admitted that his model, like those of Solms and Hobson, is just a hypothesis. All three theories are

only partially supported by experimental results.

Two millennia after Artemidorus Daldianus, there is still plenty to learn. Until conclusive evidence falsifies one of these theories or substantiates a new one, we can simply go along with a paraphrase of French playwright Victor Hugo, which has been neither proved nor contradicted: Thought is the labor of the intellect; dreaming is its pleasure.

(Further Reading)

- ◆ **The Neuropsychology of Dreams: A Clinico-Anatomical Study.** Mark Solms. Lawrence Erlbaum Associates, 1997.
- ◆ **Dreaming: An Introduction to the Science of Sleep.** J. Allan Hobson. Oxford University Press, 2004.



The Truth and the Hype of HYPNOSIS

THOUGH OFTEN DENIGRATED AS FAKERY OR WISHFUL THINKING, HYPNOSIS HAS BEEN SHOWN TO BE A REAL PHENOMENON WITH A VARIETY OF THERAPEUTIC USES—ESPECIALLY IN CONTROLLING PAIN

BY MICHAEL R. NASH AND GRANT BENHAM

PHOTOGRAPHS BY KYOKO HAMADA

“You are getting sleepy. Verrrry sleepy...” A waistcoated man swings his pocket watch back and forth before the face of a young woman seated in a Victorian-era parlor. She fixes her gaze on the watch, tracking its pendular motion with her eyes. Moments later she is slumped in her chair, eyes closed, answering the hypnotist’s questions in a zombie-like monotone.

Everyone has seen a depiction of hypnosis similar to this one in movies and on television. Indeed, say the word “hypnosis,” and many people immediately think of pocket watches. But it is now much more common for hypnotists simply to ask a subject to stare at a small, stationary object—such as a colored thumbtack on a blank wall—during the “induction patter,” which usually consists of soothing words about relaxation and suggestions to concentrate.

But is hypnosis a real phenomenon? If so, what is it useful for? Over the past few years, researchers have found that hypnotized individuals actively respond to suggestions even though they sometimes perceive the dramatic changes in thought and behavior they experience as happening “by themselves.” During hypnosis, it is as though the brain temporarily suspends its attempts to authenticate incoming sensory information. Some people are

more hypnotizable than others, although scientists still don't know why. Nevertheless, hypnosis is finding medical uses in controlling chronic pain, countering anxiety and even—in combination with conventional operating-room procedures—helping patients to recover more quickly from outpatient surgery.

Only in the past 40 years have scientists been equipped with instruments and methods for discerning the facts of hypnosis from exaggerated claims. But the study of hypnotic phenomena is now squarely in the domain of normal cognitive science, with papers on hypnosis published in

(between 5 and 7); 95 percent of the population receives a score of at least 1.

What Hypnosis Is

Based on studies using the Stanford scales, researchers with very different theoretical perspectives now agree on several fundamental principles of hypnosis. The first is that a person's ability to respond to hypnosis is remarkably stable during adulthood. In perhaps the most compelling illustration of this tenet, a study showed that when retested, Hilgard's original subjects had roughly the same scores on the Stanford scales as

Hypnosis can boost the effectiveness of psychotherapy for obesity, insomnia and anxiety.)

some of the most selective scientific and medical journals. Of course, spectacles such as "stage hypnosis" for entertainment purposes have not disappeared. But the new findings reveal how, when used properly, the power of hypnotic suggestion can alter cognitive processes as diverse as memory and pain perception.

Wheat from the Chaff

To study any phenomenon properly, researchers must first have a way to measure it. In the case of hypnosis, that yardstick is the Stanford Hypnotic Susceptibility Scales. The Stanford scales, as they are often called, were devised in the late 1950s by Stanford University psychologists André M. Weitzenhoffer and Ernest R. Hilgard and are still used today to determine the extent to which a subject responds to hypnosis. One version of the Stanford scales, for instance, consists of a series of 12 activities—such as holding one's arm outstretched or sniffing the contents of a bottle—that test the depth of the hypnotic state. In the first instance, individuals are told that they are holding a very heavy ball, and they are scored as "passing" that suggestion if their arm sags under the imagined weight. In the second case, subjects are told that they have no sense of smell, and then a vial of ammonia is waved under their nose. If they have no reaction, they are deemed very responsive to hypnosis; if they grimace and recoil, they are not.

Scoring on the Stanford scales ranges from 0, for individuals who do not respond to any of the hypnotic suggestions, to 12, for those who pass all of them. Most people score in the middle range

they did 10, 15 or 25 years earlier. Studies have shown that an individual's Stanford score remains as consistent over time as his or her IQ score—if not more so. In addition, evidence indicates that hypnotic responsiveness may have a hereditary component: identical twins are more likely than same-sex fraternal twins to have similar Stanford scores.

A person's responsiveness to hypnosis also remains fairly consistent regardless of the characteristics of the hypnotist: the practitioner's gender, age and experience have little or no effect on a subject's ability to be hypnotized. Similarly, the success of hypnosis does not depend on whether a subject is highly motivated or especially willing. A very responsive subject will become hypnotized under a variety of experimental conditions and therapeutic settings, whereas a less susceptible person will not, despite his or her sincere efforts. (Negative attitudes and expectations can, however, interfere with hypnosis.)

Studies have also shown that hypnotizability is unrelated to personality characteristics such as gullibility, hysteria, psychopathology, trust, aggressiveness, submissiveness or imagination. Nor are highly hypnotizable individuals any more responsive than others to social influences such as misleading questions or peer pressure. The trait has, however, been linked tantalizingly with a person's ability to become absorbed in activities such as reading, listening to music or daydreaming.

Indeed, a highly hypnotizable person's capacity for effortless absorption might in part be determined by brain morphology. In 2004 James E. Horton of the University of Virginia's College at

Wise and Helen J. Crawford of Virginia Polytechnic Institute and State University showed with MRI images that the rostrum part of the corpus callosum was 32 percent larger for highly hypnotizable subjects than for subjects who were not susceptible to hypnosis. This brain region plays a role in allocating attention and in the inhibition of unwanted stimuli.

Under hypnosis, subjects do not behave as passive automatons but instead are active problem solvers who incorporate their moral and cultural ideas into their behavior while remaining exquisitely responsive to the expectations expressed by the experimenter. Nevertheless, the subject does not experience hypnotically suggested behavior as something that is actively achieved. To the contrary, it is typically deemed as effortless—as something that just happens. People who have been hypnotized often say things like “My hand became heavy and moved down by itself” or “Suddenly I found myself feeling no pain.”

Many researchers now believe that these types of disconnections are at the heart of hypnosis. In response to suggestion, subjects make movements without conscious intent, fail to detect exceedingly painful stimulation or temporarily forget a familiar fact. Of course, these kinds of things also happen outside hypnosis—occasionally in day-to-day life and more dramatically in certain psychiatric and neurological disorders.

Using hypnosis, scientists have temporarily created hallucinations, compulsions, certain types of memory loss, false memories, and delusions in the laboratory so that these phenomena can be studied in a controlled environment.

What Hypnosis Isn't

As scientists discover more about hypnosis, they are also uncovering evidence that counters some of the skepticism about the technique. One such objection is that hypnosis is simply a matter of having an especially vivid imagination. In fact, this does not seem to be the case. Many imaginative people are not good hypnotic subjects, and no relation between the two abilities has surfaced.

The imagination charge stems from the fact that many people who are hypnotizable can be led to experience compellingly realistic auditory and visual hallucinations. But an elegant study using positron emission tomography (PET), which indirectly measures metabolism, has shown that different regions of the brain are activated when a subject is asked to imagine a sound than when he or she is hallucinating under hypnosis.

In 1998 Henry Szechtman of McMaster Uni-



versity in Ontario and his co-workers used PET to image the brain activity of hypnotized subjects who were invited to imagine a scenario and who then experienced a hallucination. The researchers noted that an auditory hallucination and the act of imagining a sound are both self-generated and that, like real hearing, a hallucination is experienced as coming from an external source. By monitoring regional blood flow in areas activated during both hearing and auditory hallucination but not during simple imagining, the investigators sought to determine where in the brain a hallucinated sound is mistakenly “tagged” as authentic and originating in the outside world.

Szechtman and his colleagues imaged the

It doesn't take much to induce hypnosis: staring fixedly at a spot on the wall and listening to the soothing voice of a hypnotist will do the trick for most people.

(The Authors)

MICHAEL R. NASH is professor of psychology at the University of Tennessee at Knoxville. He researches and publishes on human memory, dissociative pathology, sex abuse, psychotherapy and hypnosis. **GRANT BENHAM** is assistant professor at the University of Texas–Pan American and investigates mind-body interactions, hypnosis and psychoneuroimmunology.



People under hypnosis, though deeply relaxed, can carry out the instructions of their hypnotist. This woman is being told that her arm is becoming as heavy as lead. Highly hypnotizable subjects will lower their arm under the imagined weight.

brain activity of eight very hypnotizable subjects who had been prescreened for their ability to hallucinate while hypnotized. During the session, the subjects were under hypnosis and lay in the PET scanner with their eyes covered. Their brain activity was monitored under four conditions: at rest; while hearing an audiotape of a voice saying, "The man did not speak often, but when he did, it was worth hearing what he had to say"; while imagining hearing the voice again; and during the auditory hallucination they experienced after being told that the tape was playing once more, although it was not.

The tests showed that a region of the brain called the right anterior cingulate cortex was just as active while the volunteers were hallucinating as it was while they were actually hearing the stimulus. In contrast, that brain area was not active while the subjects were imagining that they heard the stimulus. Somehow hypnosis had tricked this area of the brain into registering the hallucinated voice as real.

Another objection raised by critics of hypnosis concerns its ability to blunt pain. Skeptics have argued that this effect results from either simple relaxation or a placebo response. But a number of experiments have ruled out these explanations. In a classic 1969 report, Thomas H. McGlashan and

his colleagues at the University of Pennsylvania found that for poorly hypnotizable people, hypnosis was as effective in reducing pain as a sugar pill that the subjects had been told was a powerful painkiller. But highly hypnotizable subjects benefited three times more from hypnosis than from the placebo. In another study, in 1976, Hilgard and Stanford colleague Éva I. Bányai observed that subjects who were vigorously riding stationary bicycles were just as responsive to hypnotic suggestions as when they were hypnotized in a relaxing setting.

In 1997 Pierre Rainville of the University of Montreal and his colleagues set out to determine which brain structures are involved in pain relief during hypnosis. They attempted to locate the brain structures associated with the suffering component of pain, as distinct from its sensory aspects. Using PET, the scientists found that hypnosis reduced the activity of the anterior cingulate cortex—an area involved in pain—but did not affect the activity of the somatosensory cortex, where the sensations of pain are processed.

Despite these findings, however, the mechanisms underlying hypnotic pain relief are still poorly understood. The model favored by most researchers is that the analgesic effect of hypnosis occurs in higher brain centers than those involved in registering the painful sensation. This would account for the fact that most autonomic responses that routinely accompany pain—such as increased heart rate—are relatively unaffected by hypnotic suggestions of analgesia.

But couldn't people merely be faking that they had been hypnotized? Two key studies have put such suspicions to rest.

In a cunning 1971 experiment dubbed the Disappearing Hypnotist, Frederick Evans and Martin T. Orne of the University of Pennsylvania compared the reactions of two groups of subjects: one made up of people they knew to be truly hypnotizable and another of individuals they told to pretend to be hypnotized. An experimenter who did not know which group was which conducted a routine hypnotic procedure that was suddenly interrupted by a bogus power failure. When the experimenter left the room to investigate the situation, the pretending subjects immediately stopped faking: they opened their eyes, looked around the room and in all respects dropped the pretense. The real hypnotic subjects, however, slowly and with some difficulty terminated hypnosis by themselves.

Fakers also tend to overplay their role. When subjects are given suggestions to forget certain

aspects of the hypnosis session, their claims not to remember are sometimes suspiciously pervasive and absolute, for instance, or they report odd experiences that are rarely, if ever, recounted by real subjects. Taru Mustonen, now at the Harvard School of Dental Medicine, Harold S. Zamansky of Northeastern University and their co-workers have exposed fakers using traditional lie detector tests. They have found that when real hypnotic subjects answer questions under hypnosis, their physiological reactions generally meet the criteria for truthfulness, whereas those of simulators do not.

Hypnosis and Memory

Perhaps nowhere has hypnosis engendered more controversy than over the issue of “recovered” memory. Cognitive science has established that people are fairly adept at discerning whether an event actually occurred or whether they only imagined it. But under some circumstances, we falter. We can come to believe (or can be led to believe) that something happened to us when, in fact, it did not. One of the key cues humans appear to use in making the distinction between reality and imagination is the experience of effort. Apparently, at the time of encoding a memory, a

“tag” cues us as to the amount of effort we expended: if the event is tagged as having involved a good deal of mental effort on our part, we tend to interpret it as something we imagined. If it is tagged as having involved relatively little mental effort, we tend to interpret it as something that actually happened to us. Given that the calling card of hypnosis is precisely the feeling of effortlessness, we can see why hypnotized people can so easily mistake an imagined past event for something that happened long ago. Hence, something that is merely imagined can become ingrained as an episode in our life story.

A host of studies verify this effect. Readily hypnotized subjects, for instance, can routinely be led to produce detailed and dramatic accounts of their first few months of life even though those events did not in fact occur and even though adults simply do not have the capacity to remember early infancy. Similarly, when given suggestions to regress to childhood, highly hypnotizable subjects behave in a roughly childlike manner, are often quite emotional and may later insist that they were genuinely reliving childhood. But research confirms that these responses are in no way authentically childlike—not in speech, behavior, emotion, perception, vocabulary or

What Do You Know about Hypnosis?

If You Think ...	The Reality Is ...
It's all a matter of having a good imagination.	Ability to imagine vividly is unrelated to hypnotizability.
Relaxation is an important feature of hypnosis.	It's not. Hypnosis has been induced during vigorous exercise.
It's mostly just compliance.	Many highly motivated subjects fail to experience hypnosis.
It's a matter of willful faking.	Physiological responses indicate that subjects are not lying.
It is dangerous.	Standard procedures are no more distressing than lectures.
It has something to do with a sleeplike state.	It does not. Hypnotized subjects are fully awake.
Certain personality types are likely to be hypnotizable.	There are no substantial correlates with personality measures.
People who are hypnotized lose control of themselves.	Subjects are capable of saying no or terminating hypnosis.
Hypnosis can enable people to “relive” the past.	Age-regressed adults behave like adults playacting as children.
A person's responsiveness to hypnosis depends on the technique used and who administers it.	Neither is important under laboratory conditions. It is the subject's capacity that is important.
When hypnotized, people can remember more accurately.	Hypnosis may actually muddle the distinction between memory and fantasy and may artificially inflate confidence.
Hypnotized people can be led to do acts that conflict with their values.	Hypnotized subjects fully adhere to their usual moral standards.
People do not remember what happens during hypnosis.	Posthypnotic amnesia does not occur spontaneously.
Hypnosis can enable people to perform otherwise impossible feats of strength, endurance, learning and sensory acuity.	Performance following hypnotic suggestions for increased muscle strength, learning and sensory acuity does not exceed what can be accomplished by motivated subjects outside hypnosis.

Scientific American Gets Hypnotized

STAFFERS SEE WHAT IT'S LIKE TO "GO UNDER"

The editors at *Scientific American* pride themselves on their skepticism toward pseudoscience and on their hard-nosed insistence on solid research. So in 2001 they invited Michael R. Nash of the University of Tennessee at Knoxville and research psychologist Grant Benham to New York City so they could see what hypnosis was like firsthand. Six editorial staffers—three men and three women, none of whom had been hypnotized before—were willing to give it a try. The outcome surprised them.

Nash and Benham set up two quiet offices. Each researcher hypnotized three people individually, spending about an hour with each subject. They took each volunteer through the Stanford Hypnotic Susceptibility Scales, which rate an individual's responsiveness from 0 to 12.

One of the most surprising things about the hypnotic experience was its very banality. To induce hypnosis, Nash and Benham merely asked the staffers to stare at a yellow Post-It note on the wall and spoke in a calm voice about how relaxed they were becoming and how their eyes were growing tired. "Your whole body feels heavy—heavier and heavier," they read from the Stanford script. "You are beginning to feel drowsy—drowsy and sleepy. More and more drowsy and sleepy while your eyelids become heavier and heavier, more and more tired and heavy." That soothing patter went on for roughly 15 minutes, after which all but one volunteer had closed his or her eyes without being directly told to do so.

The Stanford scales consist of 12 different activities ranging from trying to pull apart one's interlocked fingers and feeling one's elevated arm lower involuntarily to hallucinating that one hears a buzzing fly. Of the six subjects, one scored an 8, one a 7, one a 6, two a 4 and one a 3. (A score of 0 to 4 is considered "low" hypnotizable; 5 to 7 is "medium" hypnotizable; 8 to 12 is "high" hypnotizable.) No one accurately predicted how susceptible they would be: some who thought themselves very suggestible turned out to be poor subjects, and others who deemed themselves tough cases were surprised to find their two outstretched arms coming together by

People are aware of what they do during hypnosis, although their actions feel involuntary. Some laugh at their inability to say their name or open their eyes under hypnotic suggestion.

themselves or their mouth clamped shut so that they couldn't say their name.

Everyone had a sense of "watching" themselves and were sometimes amused. "I knew what my name was, but I couldn't think how to move my mouth," recalled one staff member. Another said his fingers "felt stuck" during the finger-lock exercise. "At first they pulled apart easily enough, but then they seemed to sort of latch up. It was interesting to see that it was so difficult."

Only one person experienced item number 12 on the Stanford scale—posthypnotic amnesia. In this exercise, the hypnotist tells the subject not to remember what occurred during the session. "Every time I'd try to remember," said the staff member who had this sensation, "the only thing that came back to me was that I shouldn't remember. But when Dr. Benham said it was okay to remember, it all came flooding back."

In general, the experience was much less eerie than expected. The feeling was akin to falling into a light doze after you've awakened in the morning but while you're still in bed. All of the volunteers found that they felt less hypnotized during some parts of the session than during others, as if they had come near the "surface" for a few moments and then slipped under again.

All in all, the staff concluded that seeing is believing when it comes to hypnosis. Or maybe hearing is believing: I'm the one who heard—and swatted—the imaginary fly.

—Carol Ezzell Webb, former staff writer
(7 on the Stanford scales)



thought patterns. These performances are no more childlike than those of adults playacting as children. In short, nothing about hypnosis enables a subject to transcend the fundamental nature and limitations of human memory. It does not allow someone to exhume memories that are decades old or to retrace or undo human development.

What It's Good For

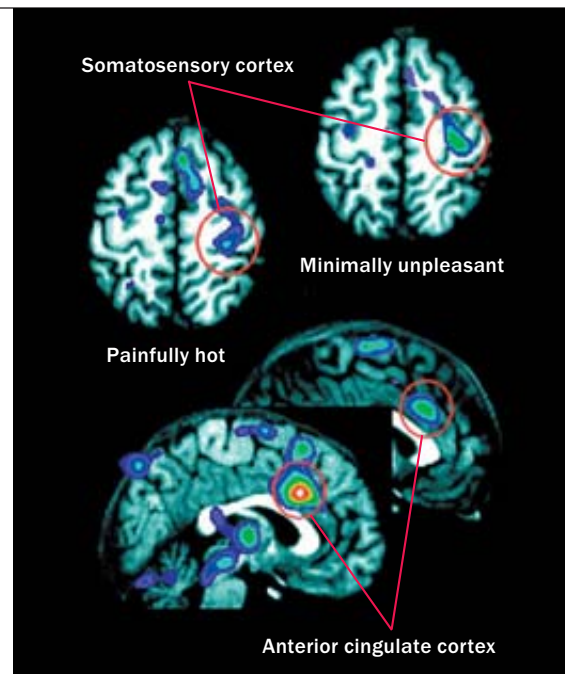
So what are the medical benefits of hypnosis? A 1996 National Institutes of Health technology assessment panel judged hypnosis to be an effective intervention for alleviating pain from cancer and other chronic conditions. Voluminous clinical studies also indicate that hypnosis can reduce the acute pain experienced by patients undergoing burn-wound debridement, children enduring bone marrow aspirations and women in labor. A meta-analysis published in a special issue of the *International Journal of Clinical and Experimental Hypnosis*, for example, found that hypnotic suggestions relieved the pain of 75 percent of 933 subjects participating in 27 different experiments. The pain-relieving effect of hypnosis is often substantial, and in a few cases the degree of relief matches or exceeds that provided by morphine.

But the Society for Clinical and Experimental Hypnosis says that hypnosis cannot, and should not, stand alone as the sole medical or psychological intervention for any disorder. The reason is that anyone who can read a script with some degree of expression can learn how to hypnotize someone. An individual with a medical or psychological problem should first consult a qualified health care provider for a diagnosis. Such a practitioner is in the best position to decide with the patient whether hypnosis is indicated and, if it is, how it might be incorporated into the individual's treatment.

Hypnosis can boost the effectiveness of psychotherapy for some conditions. Another meta-analysis that examined the outcomes of people in 18 separate studies found that patients who received cognitive behavioral therapy plus hypnosis for disorders such as obesity, insomnia, anxiety and hypertension showed greater improvement than 70 percent of those who received psychotherapy alone. After publication of these findings, a task force of the American Psychological Association validated hypnosis as an adjunct procedure for the treatment of obesity. But the jury is still out on other disorders with a behavioral component. Drug addiction and alcoholism do not respond well to hypnosis, and the evidence for hypnosis as an aid in quitting smoking is equivocal.

That said, there is strong but not yet definitive

Hypnosis might alleviate pain by decreasing the activity of brain areas involved in the experience of suffering. Positron emission tomography scans were taken while the hands of hypnotized volunteers were dunked into painfully hot water. The activity of the somatosensory cortex, which processes physical stimuli, did not differ whether a subject was given the hypnotic suggestion that the sensation would be painfully hot (top left) or that it would be minimally unpleasant (right). In contrast, a region involved in the suffering aspect of pain, the anterior cingulate cortex, was much less active when subjects were told the pain would be minimally unpleasant (bottom right).



evidence that hypnosis can be an effective component in the broader treatment of other conditions. Listed in rough order of tractability by hypnosis, these include a subgroup of asthmas; some dermatological disorders, including warts; irritable bowel syndrome; hemophilia; and nausea associated with chemotherapy. The mechanism by which hypnosis alleviates these disorders is unknown, and claims that hypnosis increases immune function in any clinically important way are at this time unsubstantiated.

More than 30 years ago Hilgard predicted that as knowledge about hypnosis becomes more widespread in the scientific community, a process of "domestication" will take place: researchers will use the technique more and more often as a routine tool to study other topics of interest, such as hallucination, pain and memory. He forecast that, thus grounded in science, the clinical use of hypnosis would simply become a matter of course for some patients with selected problems. Although we are not quite there today, hypnosis has nonetheless come a long way from the swinging pocket watch.

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Magnetically stimulating the brain could lift depression and perhaps even boost creativity, but questions remain

BY HUBERTUS BREUER

A GREAT ATTRACTION

When American psychiatrist Mark S. George stepped into the elevator of a London hospital in 1990, he had no idea the short ride would transform his research career. A fellow passenger was having a giggling fit for no apparent reason. When George inquired about the outburst of merriment, the man replied that a doctor had held a magnetic coil against his head and that it had made his thumb twitch uncontrollably.

Even though the tale sounded a bit like quackery, George was curious. He contacted the doctor, who said he had stimulated the man's motor cortex, located at the top of the head, in hopes of seeing whether it would spark



TMS appears to temporarily lift the veil of depression by promoting the release of certain neurotransmitters.

a signal to any muscles. The doctor had learned about what researcher Anthony T. Barker of the University of Sheffield in England did in the mid-1980s: Barker transmitted 4,000 amperes of current through a copper coil to create a strong, tight magnetic field, then held his homemade device against his own head. His thumb suddenly jerked up involuntarily. The magnetic field had obviously been strong enough to deliver a stimulus to the brain through the skull—"transcranially."

George asked the doctor if he had ever tried the device on the frontal regions of the cortex. The doctor replied no and wondered out loud why anyone would want to do that. When George returned to his laboratory at the Medical University of South Carolina, he proceeded to answer the question himself. He had a hunch that if the technique worked, it could perhaps help patients suffering from severe depression, for whom conventional

treatment with antidepressant medication had failed. George focused a strong magnetic field on the left prefrontal cortex—the region of the brain that is underactive in clinically depressed people—and found that the mood of two of his patients improved, at least for a few days.

Since that time, interest in transcranial magnetic stimulation, or TMS, has blossomed. Physicians have since reported success in curbing epileptic convulsions and even in reducing the notorious shakes of Parkinson's disease. Some investigators today also hope to awaken hidden creativity and heighten consciousness in the average person. Others are skeptical, however, because controlled trials have been few, and even George warns against touting the young technique as a panacea.

"It is still unclear exactly what this method does to the brain," he says, "and anything that has the power to heal can also certainly harm." It is worth noting, too, that although the U.S. Food and Drug Administration has approved TMS devices for diagnostic applications, it has not approved them for any kind of therapeutic use.

Better than Shock Treatment

The basic principle of TMS is simple. A coil of wire is placed near the head. Alternating current flowing through the coil induces a magnetic field with a strength of up to 2.5 teslas (one tesla is 20,000 times the strength of the earth's magnetic field). The field passes harmlessly through the skull and influences the electrical signals passing among neurons in the brain.

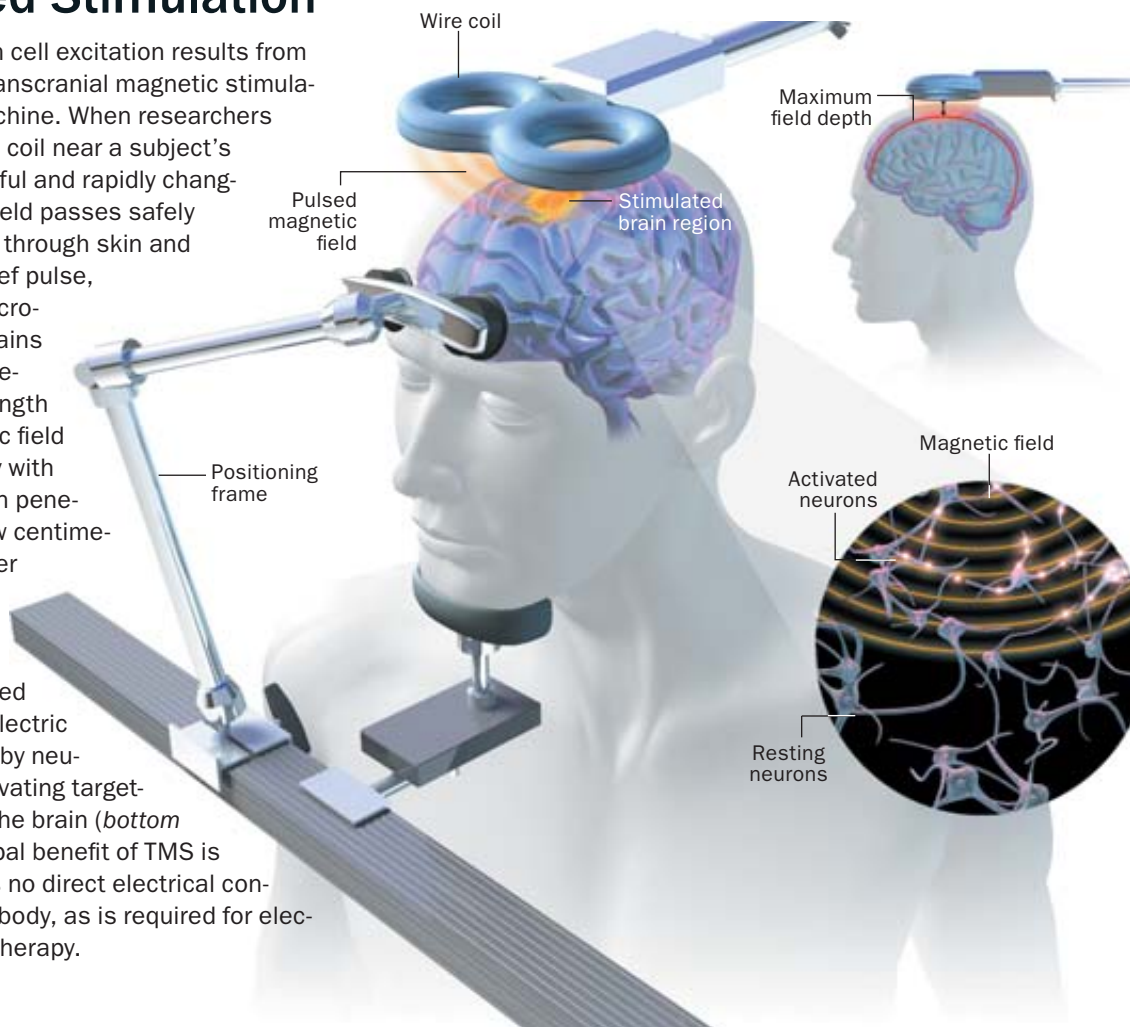
Physicians hold the coil close to whichever brain region they are interested in stimulating. One variation, known as repetitive transcranial magnetic stimulation (rTMS), is to switch the current on and off from one to 100 times a minute, which creates a series of magnetic impulses. This approach is often used in experiments on people with depression. Remarkably, rTMS can elicit two opposing reactions: a low frequency will block neural activity, yet higher frequencies will stimulate it. It is the stimulation that appears to lift the veil of depression, perhaps by promoting the release of important neurotransmitters, such as serotonin, which can raise activity in neurons to normal levels.

(Controlled trials have been few, and it is still unclear how the technique affects neurons.)

STONE+ GETTY IMAGES (preceding pages); JAMES SALZANO, IMAGING BY TRILOBYTE (this page)

Targeted Stimulation

Localized brain cell excitation results from the use of a transcranial magnetic stimulation (TMS) machine. When researchers operate a TMS coil near a subject's scalp, a powerful and rapidly changing magnetic field passes safely and painlessly through skin and bone. Each brief pulse, lasting only micro-seconds, contains little energy. Because the strength of the magnetic field falls off rapidly with distance, it can penetrate only a few centimeters to the outer cortex of the brain (*top right*). The precisely located field induces electric current in nearby neurons, thus activating targeted regions of the brain (*bottom right*). A principal benefit of TMS is that it requires no direct electrical connection to the body, as is required for electroconvulsive therapy.



The magnetic wand offers several advantages over other therapeutic methods. It is noninvasive and painless. Subjects have reported no discomfort other than what they describe as a slight pull on the scalp. Mild headaches are common side effects, but they seem to be relieved readily with typical over-the-counter medication. The apparatus, however, makes a loud noise, which can be annoying. And a handful of patients have had seizures. Yet this seems, overall, more palatable than the side effects of the primary technique used on severely depressed patients who do not respond to medication—electroconvulsive therapy, better known as shock treatment. In this approach, a patient is given general anesthesia as well as muscle relaxants. A strong electrical impulse is delivered through electrodes on the patient's head, triggering a convulsion in the brain. This uncontrolled thunderstorm of neuronal firing relieves depression for a short time for roughly 80 percent of cases, which is encouraging, yet subjects also

often experience heart palpitations as well as subsequent confusion and memory lapses.

The positive effects of TMS are intriguing. In 1999 Ehud Klein, a psychologist at the Rambam Medical Center in Haifa, Israel, led the largest study to date. Klein exposed 70 patients suffering from major depression to 10 daily sessions of repetitive TMS over a two-week period. Half received real TMS, and half received a sham version—the magnet was held at an angle that rendered the field ineffective. The mood of participants who had been properly exposed improved on the Hamilton Depression Rating Scale, used to assess symptoms. But no change was found for subjects who had sat under the ineffective coils.

TMS is still in an extended experimental

(The Author)

HUBERTUS BREUER is a science journalist in New York City and has a doctorate in philosophy.

Magnetically stoking neural networks could boost creativity, but that notion is a leap of faith.

stage, however. Only a few trials, involving a small number of test subjects, have been published; there has been little follow-up. The types of people, brain locations, coil configurations, and magnetic field strengths and frequencies have varied considerably, making it practically impossible to compare study results. Positive effects, if they exist, may result from a combination of all the variables, George says, “and I doubt that we’ve hit upon the most effective arrangement.” A metastudy of depression trials also concluded there was no strong evidence of benefit.

Another deficit is that therapeutic effects

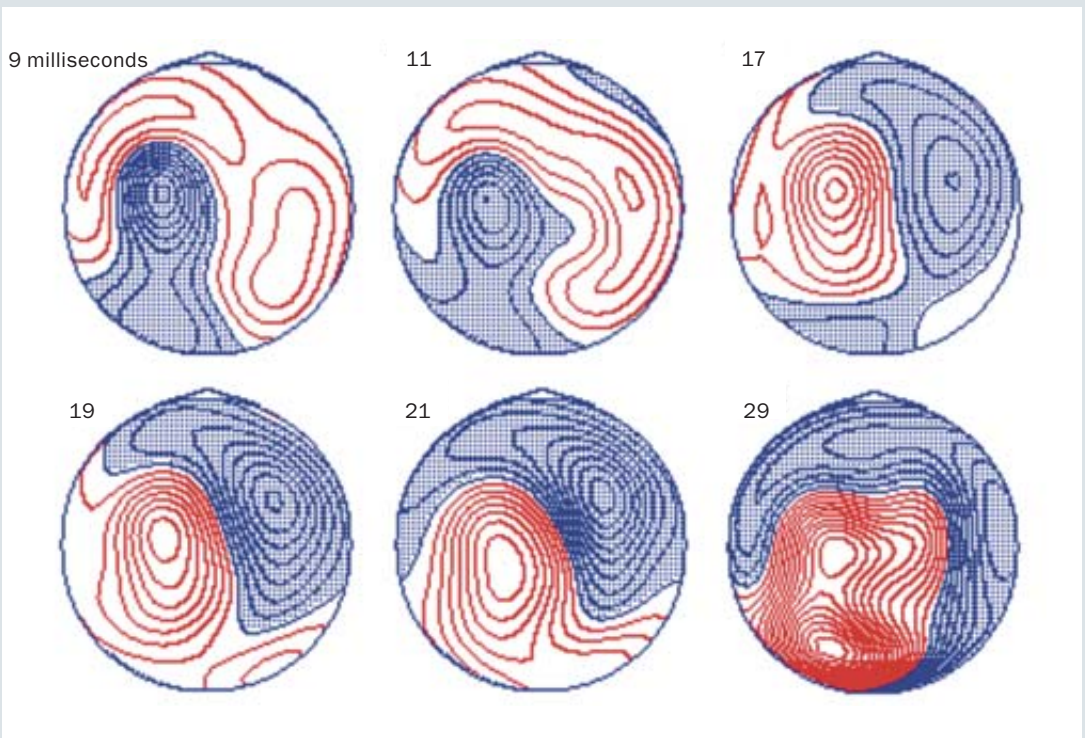
seem to last only a few days to a few weeks. For example, Thomas Schlaepfer, a psychiatrist at the University of Bonn in Germany, was able to reduce obsessive behavior in one of his female patients. For years, the woman had found it necessary to perform a series of complicated rituals before she could pass through a doorway, but after a TMS session she was immediately able to walk from one room to the next with no hesitation. Unfortunately, she reverted to her old behavior after only a week.

Still, even this duration shows that the effect on neurons does not disappear as soon as the coil

Stimulating Topography

To show how TMS first concentrates and then spreads, Jarmo Ruuhonen, now at Nexstim, Ltd., in Helsinki, Finland, used electroencephalographic sensors to track electrical activity after a TMS pulse. The diagrams show one subject’s head as seen from above (the nose is at 12 o’clock). A magnetic pulse was initiated over the left-hand

motor area. Positive electrical waves (*blue*) radiated around to the head’s right side as negative potentials (*red*) convened in the left side. Beyond 29 milliseconds the activation pattern became complicated, in part because electrical activity had arisen in response to the subject’s hearing the noise the TMS instrument makes.



COURTESY OF JARMO RUUHONEN

is removed. The procedure does more than simply intervene among neurons; it somehow transforms the neuronal network for a time. Molecular studies by neuropsychologist Armand Hausmann of Innsbruck Medical University in Austria suggest that TMS stimulates neuronal factors that are known to aid in cell growth.

Devil in the Details

If TMS can promote neuron growth, then it could potentially help people who suffer from degenerative brain diseases such as Alzheimer's, although that is speculation. Strengthening neural networks means that TMS could perhaps promote cognition and creativity, too. These possibilities require some leaps of faith, but a smaller step can be gleaned from TMS's history thus far. The technique has been most widely used as a diagnostic tool to stimulate specific regions of the cortex, helping neurologists gauge their function.

When Alvaro Pascual-Leone, a brain researcher at Beth Israel Deaconess Medical Center in Boston, managed to direct a coil at the language center of his participants, they suddenly could not utter a single word. TMS literally left them speechless. Peter Eichhammer of the University of Regensburg in Germany has provided at least some relief for people who suffer from tinnitus—a persistent, even maddening ringing or buzzing in the brain. After five half-hour treatment cycles, some participants reported a substantial decrease in background noise, which for a few individuals lasted up to six months.

Other work is further on the fringe. George has an agreement with the U.S. Department of Defense to try to use magnetic stimulation to keep fighter pilots alert and attentive. The dream is a TMS helmet that will animate exhausted soldiers back into battle. Michael A. Persinger of Laurentian University in Ontario has wired magnetic coils inside a motorcycle helmet that he says has enabled experimental subjects to believe they sense the presence of a supernatural being; some have reported encounters with a guardian angel; still others state they have encountered Satan. As a result, Persinger suspects that spiritual experiences are nothing more than a product of our brains.

Your Inner Savant

More tangible, but equally elusive, is the notion that TMS could heighten creativity. Allan Snyder, director of the Center for the Mind in Canberra and Sydney, Australia, foresees a “thinking cap” that will help psychologically healthy individuals

attain unimagined heights of consciousness. He would like to awaken the slumbering genius in all of us with a kind of magnetic brain doping.

Snyder's inspiration comes from savants—autistic and other severely handicapped individuals who nonetheless display remarkable skills in certain cognitive areas. Some are gifted musicians, mathematical geniuses or outstanding artists. In most savants, the left hemisphere of the brain, considered to be the chief regulator for behavior, is chronically underactive. Snyder believes that the right side of the brain compensates with increased activity, bringing latent talents to the fore. He contends that temporarily switching off the left hemisphere with magnetic fields could allow pent-up creativity in the right hemisphere to spring forth. “I've always wanted to know what would happen if we could suddenly see the world without any censorship,” Snyder says. He reports that he has temporarily slowed the left hemisphere's activity in test subjects and that their thinking became less reason-driven, less stuck in its tracks.

The popular media has seized on Snyder's work and made it appear that such sharp targeting of our brain is already a reality. But scientists harbor a number of well-founded objections to findings of anything that could be called heightened creative skills. Yet speculation about fanciful applications abound. For example, students could block a brain region responsible for anxiety before an exam, improving their performance. In theory, no part of one's mind would be shielded from magnetic influence. If true, could TMS make people always speak the truth, vote for a specific political party or even murder someone? Although such potential misuse of TMS may only be a threat in the distant future, this technology calls for ethical discussions today.

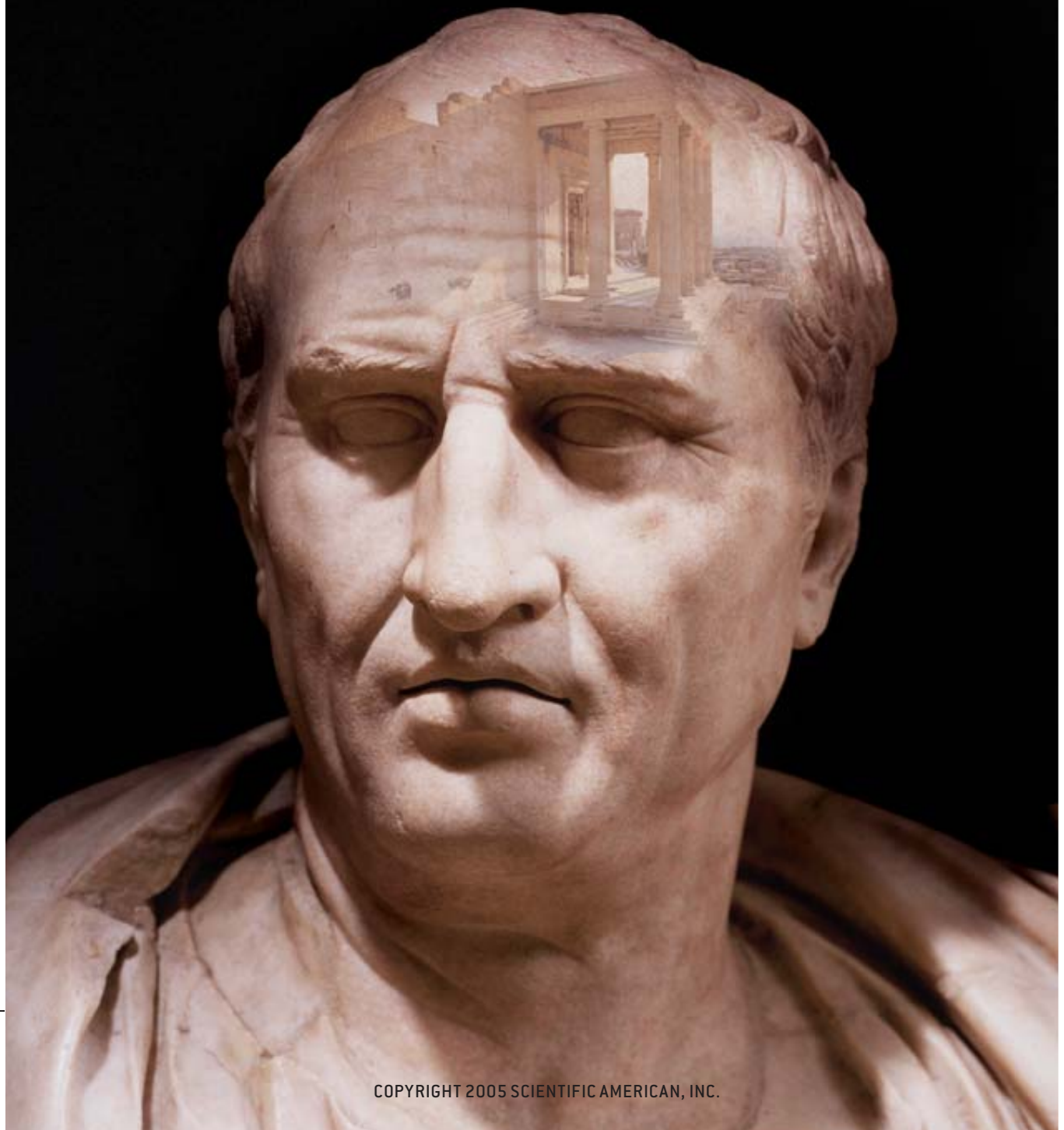


Researchers have magnetically suppressed the persistent buzzing sound in the brains of tinnitus sufferers, sometimes with lasting effects.

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Your Own HALL OF



ARCHIVO ICONOGRAFICO, S.A. CORBIS (bust of Cicero); CORBIS (Acropolis)

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MEMORIES

Want to improve your recall?
Borrow a trick from the Greeks and Romans

The main dinner course was just being served in the massive, ancient Greek hall when the expansive ceiling collapsed, crushing every one of the many guests in their seats. Not a single attendee survived, except for the poet Simonides, who had left the room just before the tragedy. In the days that followed, workers who lifted the heavy rubble found that the victims were so horribly disfigured that they were impossible to identify. But Simonides was able to help. By mentally walking alongside the long table, he found he could reconstruct which guest had been sitting in which place. Based on where the bodies lay, he named each one of the deceased.

By
**Michael
Spang**

In antiquity, mental giants such as Cicero memorized lists, poems and law books by assigning items to columns and statues in temples.

Four hundred years later Roman rhetorician Cicero (106–43 B.C.) related Simonides' story in one of his instructional books on learning and memory. Whether the diners'

Each object in a room becomes an item to be remembered at the grocery store: fish in the TV, butter on the radiator, soap as couch cushions.



Memory is aided when names, objects or ideas are visually arranged in a three-dimensional space.

deaths actually happened is not clear, but according to legend, Cicero wrote, the ceiling collapse motivated Simonides to develop a visual memory technique that still prevailed in Cicero's day, used widely by the Roman Empire's politicians and lawyers. These professionals were looked down on if they could not memorize the long speeches they often had to give; it was important for them to recite complex strains of an argument in moving oration.

The memory trick, or mnemonic, that Simonides had discovered was indeed a powerful device. Cicero made the lesson plain in his book: memory is well served when a list of names, objects or ideas is visually arranged in a three-dimensional environment.

Many people who exhibit extraordinary memory capabilities use this technique, including winners of world memory championships [see box on opposite page]. Although the method may seem peculiar at first, any person can use it to improve their recollection of anything, from shopping lists to lecture outlines. Once you find a way to "see" the items you must remember, you can use the trick on different strings of information. Most

current self-help books on improving memory or mental acuity also endorse this method, using, of course, modern strategies—and environments—that build on this ancient approach.

Soap Cushions

The mnemonic device, known as the loci method, involves placing mental pictures of items in specific locations inside a room, in a specific order. A person can then "walk" through the room and see all the objects that must be recalled. Each person must develop his or her own locational system. Teachers in antiquity recommended using public places such as temples or meeting houses as sites for spatial memory training; an individual would stand inside a temple and memorize the position of each column and statue, from the main entrance, along the right wall, across the front, back down the left wall, and so on. Each item from a list would then be assigned to a column, statue or other feature, in a given order. Later, the memorizer would visualize the room to find each item.

Today your apartment or house is often the best choice for such an exercise. To begin, define

SIGANIM

World Champ

Ben Pridmore of England is the world's memory king—at least for now. Pridmore won the 2004 World Memory Championship held in August in Manchester, prevailing over 22 competitors from nine countries.

The event, in its 14th year, is a decathlon of memory disciplines held over three days, with the winner racking up the most points. One test is a previously unpublished, nonrhyming poem that contestants have to recall exactly, line by line, including all punctuation and spelling. Competitors have 15 minutes to commit the poem to memory and 30 minutes to reproduce it. Another event involves memorizing as many binary digits (for example, 010110100) as possible in half an hour.

In the “names and faces” discipline, the mental athletes are given 100 photographs of people of various



Ben Pridmore (center), 2004 World Memory Champion.

nationalities, mostly head-and-shoulder shots. Below each image is a first and last name. The contestants have 15 minutes to study the images. They are then given the same 100 images, in a shuffled order, with no names; they have 30 minutes to write both names on each picture, earning one point per name. Briton Andi Bell won this event, correctly listing 176 of the 200 names.

One of the hallmark events is the one-hour

card memorization. The mnemonists are given shuffled decks of cards and have one hour to memorize as many as possible, in order. Pridmore recalled 1,144 cards—22 full decks.

The World Memory Championship is held by the World Memory Sports Council in Surrey, England. Information and sample tests are available at www.worldmemorychampionship.com

—Mark Fischetti

a specific route through each room and order the objects you come across: first there is the foyer, inside which is a small table, mirror, hook for keys, rug and closet door. Next is the living room, with a sofa, radiator, television and ceiling light. It is important to always follow the same sequence—to imprint a fixed locational system in your mind, which can represent standard items such as individual cards in a deck or be augmented to allow for new contents whenever a new list is needed.

As an example, let us say you are going grocery shopping and have nine items to remember: eggs, cheese, spaghetti, fish, bread, soap, butter, salami and cereal. Imagine three rooms in your home, each containing three items from the list. You enter the foyer and hang your keys on the hook shaped like a loaf of bread. You walk across the rug, but it is made of salami slices, and look into a mirror that has two fried eggs stuck to it. In the living room, the TV has become an aquarium in which a big fish swims. The fish is looking

across the room at the radiator, on which a stick of butter sits, melting. The melting butter drips down onto the sofa, whose cushions are made of bars of soap [see illustration on opposite page]. In the den you see a computer mouse nibbling at some cheese. The bookshelf above it supports a thick book—the cereal box—and the curtain rod over the window is holding curtains made of woven spaghetti.

Each station, such as the mirror and sofa, is now connected to a particular item. If the following week's list contains a chocolate bar but no cereal, then the bookshelf would be made of chocolate, but the thick book would be missing. This way, various shopping lists can be remembered, with commonly purchased items such as eggs appearing regularly and occasional items

(The Author)

MICHAEL SPANG is a philosopher and lecturer at the University of Flensburg in Germany.

Necklaces and High Heels

By Andreas Krauss

Mnemonists can commit to memory hundreds of numbers, names or symbols in only a few minutes using a mental device known as the loci method. They visually remember many objects in their house or, perhaps, a huge cathedral and assign items

from any new list to those objects. One mnemonist who has competed in world events is Steffen Bütow, a boarding school administrator in Mecklenburg, Germany. He uses his own apartment as his spatial reference. How he used this trick in the “card sprint” event at a recent contest illustrates the idea.

In the card sprint, competitors must memorize a deck of cards in as little time as possible, then arrange a new deck in the same order within five minutes. Bütow examined the deck in only 46 seconds, then blocked out light and noise with a blindfold and headphones to help him etch the order in his head (*photographs*).

The first card was the two of spades; it became a swan in his bedroom closet. The second card, the eight of diamonds, was a necklace hanging from his nightstand lamp. The seven of clubs was a whip on his pillow. The queen of hearts, high heels under the bed.

Using his inner eye, Bütow went through the deck card by card. Because the numbers and symbols are too abstract to stay in memory, he translated each card into an object, creating a 52-image slideshow. But he wasn’t just making up the objects. He had practiced for hours in the qui-



For total concentration, mnemonist Steffen Bütow dons a blindfold and soundproof headset after looking through a deck of cards he must memorize.

such as a chocolate bar appearing sporadically when needed.

Once you have worked with a set sequence for some time—say, 10 locations in each of three rooms—more rooms can be added, increasing your memory storage capacity. Regular training is required for success, however. “Without constant practice,” states an anonymous Roman book of rhetoric, *Ad Herennium*, “the rules will be practically useless. You must see to it that you have as many locations available to you as possible. The insertion of images must be practiced on a daily basis.” Adept students of the discipline can build up an incredible number of locations. In modern-day memory competitions, contestants may memorize more than 1,000 numbers in a sequence or playing cards shuffled randomly in

multiple decks. Some individuals can repeat a lengthy poem in its entirety after hearing it only once and can retell it with the stanzas in reverse order.

Your Neighbor, the Tennis Racket

Familiarity with the locational system is key, and it should remain unchanged. That is why practice matters. Compiling items from a list should also be done in creative ways, using images that are striking or whimsical—like a couch with soap cushions. *Ad Herennium* explains this in simple, logical terms: when we “see or hear something mean, big, unbelievable or ridiculous, we will probably think on it long and hard.” Sunrises and sunsets are commonplace, but a solar eclipse is not likely to be forgotten. It is therefore

PHILIPP ROTHE

et of his apartment, assigning all 52 cards to 52 objects. Whenever he is handed a newly shuffled deck, the queen of hearts is always high heels under the bed, so his task is to visualize the correct order of items for rearranging a second deck to match the first.

To reconstruct the deck, Bütow strolls along a set of routes that he has run through hundreds of times, going from his closet to the armchair, past the cabinet and nightstand, to his bed and window. The wittier or more eccentric the links, the more easily he can reproduce the order later; we remember emotionally colored situations better than neutral ones. So far Bütow has memorized 40 different routes comprising about 2,500 stops, giving him sufficient capacity for many memory tournaments.

The loci method works better the more a person trains. During competition, Bütow simply imagines that he is at home sitting at the table where he practices one to two hours each evening after his children have gone to bed, walking through his routes and card associations. Becoming a mnemonist mostly requires hard work; Bütow says he does not know a single competitor who has a photographic memory.

If you think you are mnemonist material, try the tests in the box (right). Good luck.

Andreas Krauss is a biologist and science journalist in Berlin.

important to choose images that resonate on an emotional level.

This is how the champion mnemonists work [see box above]. They use other tricks we commoners can exploit, too. For example, word memories can be helpful when meeting new people: Alan becomes “gallon,” Tony becomes “pony,” and Amanda becomes “panda.” Or you can use object memory to connect names with things based on their context; you can remember the first names of your new neighbors Alexander and Serena as a telephone (Graham Bell) and tennis racket (Williams).

With practice, you can build your visual maps to great degrees. One predecessor of today’s memory champions was Peter of Ravenna, a jurist in the late Middle Ages and author of a Latin

Test Yourself

You could be a budding mnemonist if you do well on the tests below. Get some paper, a pencil and a stopwatch. Give yourself exactly five minutes to memorize the numbers in the first list. Then cover them and write them down, in order. Take the same five-minute test with the set of words and with the playing cards.

Numbers	Words	Playing Cards
3	Sand	8 ♥
4	Blanket	7 ♦
6	Stomach	10 ♣
9	Onion	5 ♠
3	Construction fence	A ♣
5	Potato	9 ♦
7	Bed	J ♠
9	Cell phone	Q ♣
4	Broom	3 ♥
2	Scarf	7 ♥
9	Brush	
8	Snowball	
0	Iron	
1	Collar	
3	Poster	
4	Eye	
5	Cinnamon	
6	Band	
9	Intestine	
8	Fortress	

handbook on memory strategies. Peter traveled extensively in Italy, and whenever he arrived in a new city he would visit churches and cloisters and memorize their layouts. Over time he built up an impressive collection of remembered spaces—more than 100,000 locations, according to his own claims. Whether or not that number was true, he could recite in public entire law books with commentaries, innumerable Bible passages as well as hundreds of classical quotations. Given those feats, the rest of us should at least be able to handle a trip to the grocery store.

(Further Reading)

- ♦ **The Mind of a Mnemonist: A Little Book about a Vast Memory.** Aleksandr R. Luria and Jerome Bruner. Translated by Lynn Solotaroff. Harvard University Press, 1987.





HEAD ATTACK

You're late, the traffic is a nightmare and you're yelling at the kids to stop fighting in the back. Is your mental stress putting you at greater risk for a heart attack?

By Michael Feld and Johann Caspar Rüegg

Gerry suddenly clutched at his chest. His heart was racing, and he could barely breathe. Ten minutes after the call to 911, he was on his way to the nearest emergency room in an ambulance. There an electrocardiogram and blood tests provided the big shock: Gerry hadn't suffered a heart attack at all. The hospital doctor reassured him: "Physically, you are fine. Your problems are psychological in origin."

Gerry's experience is not unusual. For at least a quarter of all patients who enter hospitals with suspected heart attacks, physicians can find no physical cause for their symptoms. But it is a mistake to dismiss such occurrences as "just psychosomatic," because that minimizes the importance of the mind's effects on the body's well-being. Studies in psychosomatics, the area of medicine that deals with diseases and complaints that are at least partly psychologically based, find that one everyday aspect of modern life stands out in a startling variety of physical ailments: stress. [For a list of related ills, see box on page 71.] Worse, extreme emotional distress—caused by the death of a spouse, a furious quarrel, a natural disaster such as an earthquake, even looming

BRYAN MULLENIX Stone Getty Images

The Hostile Heart

To evaluate your overall tendency toward stressful hostility, use the Minnesota Multiphasic Personality Inventory Anger Content Scale. Answer true or false to each question:

T F

- ☐ ☐ 1. At times I feel like **swearing**.
- ☐ ☐ 2. At times I feel like **smashing** things.
- ☐ ☐ 3. Often I can't understand why I've been so **irritable and grouchy**.
- ☐ ☐ 4. At times I feel like picking a **fistfight** with someone.
- ☐ ☐ 5. I easily become **impatient** with people.
- ☐ ☐ 6. I am often said to be **hotheaded**.
- ☐ ☐ 7. I am often so **annoyed** when someone tries to get ahead of me in a line of people that I speak to that person about it.
- ☐ ☐ 8. I have at times had to be **rough** with people who were rude or annoying.
- ☐ ☐ 9. I am often sorry because I am so **irritable and grouchy**.
- ☐ ☐ 10. It makes me **angry** to have people hurry me.
- ☐ ☐ 11. I am very **stubborn**.
- ☐ ☐ 12. Sometimes I get so **angry and upset** I don't know what comes over me.
- ☐ ☐ 13. I have gotten **angry** and broken furniture or dishes when I was drinking.
- ☐ ☐ 14. I have become so angry with someone that I have felt as if I would **explode**.
- ☐ ☐ 15. I've been so angry at times that I've **hurt someone** in a physical fight.
- ☐ ☐ 16. I almost never lose **self-control**.

Anger is not a problem.
Anger level is moderate; work on ways to relax.
Anger level is a concern; your health may suffer the consequences if corrective measures are not taken.

5-0
0T-9
11-1T

heavy deadlines at work—can trigger a real heart attack in a person who is already at risk.

In the U.S. alone, 1.5 million people suffer heart attacks every year, and more than 200,000 die. It is difficult to determine how many of those incidents might be attributed to stress, but it is clear that duress plays a role. Andrew Steptoe and Philip C. Strike of University College London recently reviewed a number of medical studies conducted between 1974 and 2004 that examined what people were doing and feeling in the hours before they had a heart attack. Emotional stress was one of the most common triggers, they reported in the March/April issue of *Psychosomatic Medicine*. For example, in one study of 224 patients, more than half said they had been very upset or under stress in the 24 hours before their heart attack.

Mind over Matter

How can your head hurt your heart? To answer that question, it helps to take a look at what happens in the body when you are experiencing stress. Imagine you are ambling across a street when a car unexpectedly rounds the corner without stopping, barreling toward you. Heart pounding, legs pumping, you dash out of harm's way. What just happened?

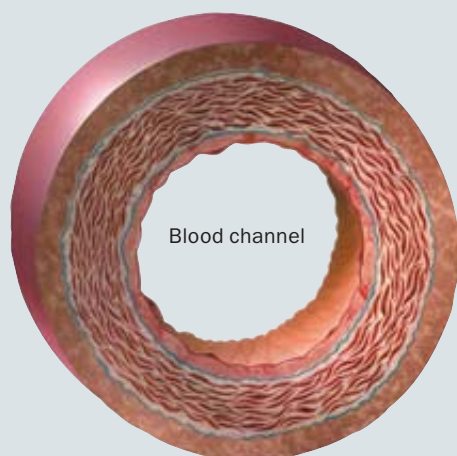
As your brain recognizes imminent danger, your body undergoes several changes. Stress hormones—epinephrine, norepinephrine, glucocorticoids—pour into your bloodstream, preparing you for a “fight or flight” response. To conserve energy for your leg muscles, nonessentials such as your digestive tract shut down. Your heart rate increases, to deliver oxygen and energy to your thighs and calves. Veins throughout the circulatory system constrict, as when you squeeze a water hose, propelling blood back to the heart more vigorously. That returning blood slams into heart walls, which in turn snap back with greater force, like a stretched rubber band. Arteries relax, increasing blood flow from the heart to those needy muscles.

Such physical reactions are helpful when you are bolting from a careless driver—or when early humans had to flee a hungry predator. And small stresses actually have an upside, because they sharpen our attention, making us feel focused and alert. (Think of playing a challenging quiz game or watching an exciting whodunit.)

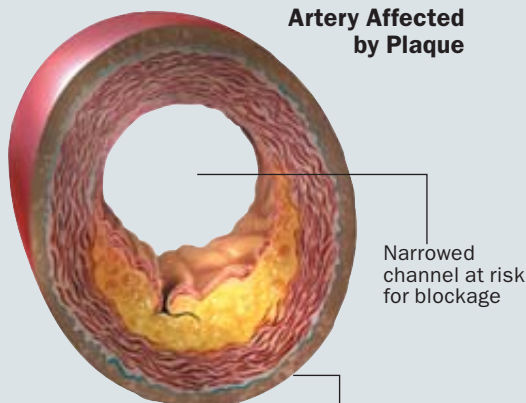
But stress also arises frequently from the everyday hassles of modern life, as we run late to that meeting, fret about getting the kids to a play date across town or worry about getting all the details just right in time for tonight's dinner par-

Heart at Risk

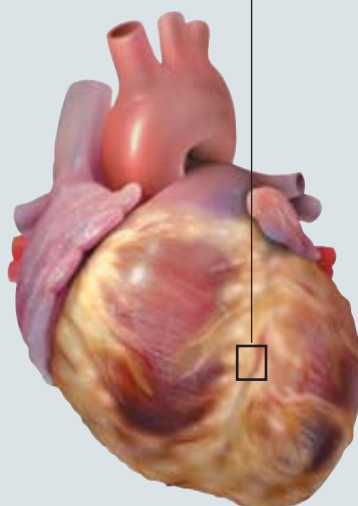
Cross Section of Healthy Coronary Artery



Artery Affected by Plaque



Chronic stress leads to high blood pressure, which in turn causes a cycle of physical changes in the body that contribute to the risk of heart attack. Among the changes is a narrowing of coronary arteries in part from the build-up of plaque. A rupture in diseased blood vessels can result in a blood clot, which can lodge in a narrowed artery, causing a heart attack. Heart cells near the blocked vessel are deprived of nutrients and oxygen, and they may die.



ty. We are especially susceptible when we feel that conditions are out of our control despite our struggles. The result is that our bodies keep working in overdrive far more than our evolutionary history has shaped us to do. Chronic stress can lead to high blood pressure. This hypertension, in turn, adds to a vicious cycle of physical changes that can tip the balance for people at risk, contributing to the onset of arrhythmia (irregular heart-beat, in which distended muscle chambers cannot efficiently pump out blood) or heart attack. In a heart attack, a clump of plaque lodges in a small vessel in the heart. The resulting blockage deprives nearby cells of nutrients and oxygen, starving them [see box above].

Stress experiments have revealed the mental mechanisms involved. In the 1990s James E. Skinner, now at the Vicor Technologies laboratory in Bangor, Pa., investigated which brain regions play a role. He worked with pigs, beginning by tying off one coronary artery to imitate the

condition of a patient with coronary artery disease. Then he implanted cooling elements at specific spots to block nerve impulses running from the frontal lobe, the location of higher-reasoning centers in the brain, to areas involved in emotional reactions and in mediating excitatory hormones: the amygdala, hypothalamus, brain stem and sympathetic nervous system. When the pigs without nerve blocks were exposed to severe psychosocial stress—such as being put in entirely new, alarming surroundings—they often experienced fatal fibrillation, a condition in which the heart contracts erratically and does not pump blood. Similarly, electrical stimulation of certain parts of the frontal lobe in the pigs elicited a rap-

(The Authors)

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id heart rate and arrhythmias, in some cases leading to cardiac arrest. The pigs whose nerves had been blocked by cold, however, were spared.

Head to Heart

So what are the important emotional factors? In the early 1900s Hungarian-American psychoanalyst and psychiatrist Franz Gabriel Alexander, now often called the father of psychosomatics, played a leading role in identifying emotional tension as a significant cause of physical illness. Alexander and other pioneers in the field believed that disorders such as ulcers, high blood pressure, neurodermatitis and asthma were the body's reaction to chronic tension and psychological stress. Following in the footsteps of psychoanalysts, they held that certain individuals—who suppressed conflicts and emotions—were predisposed to develop ailments as a result. This point of view has fallen out of favor today, as purported links between certain personality types and diseases have been refuted. For example, many studies have shown that the melancholy “cancer personality” is just a myth. On the other hand, a given person's style of dealing with problems does matter.

That is what heart specialists Meyer Friedman and Ray Rosenman concluded in 1974, after conducting a multiyear study of people with so-called Type A personalities. They claimed these individuals—whose behavior is characterized by ambition, competitiveness and impatience—have

the pinnacle of the corporate hierarchy have greater control over their day-to-day working lives than their minions. Middle-ranking employees are more likely to suffer a special kind of stress, called the negative affect. People with this sensitivity disorder exhibit above-average levels of anxiety and depression. After a multiyear study of the negative affect in men and women, Bruce C. Jonas and James F. Lando of the Centers for Disease Control and Prevention reported in the April 2000 *Psychosomatic Medicine* that such chronically stressed people are twice as likely to have hypertension as normal individuals.

Men who explode with anger or expect the worst from people may punish their own bodies as well. Such men are more likely to develop a type of arrhythmia, says an article in the March 2004 issue of *Circulation*. Feelings of hostility, for example, made men 30 percent more likely to develop the condition. Other studies have shown that a strong adverse emotion such as anger doubles the risk of heart attack during the next couple of hours. [See box on page 68 to find out if hostility might be a problem for you.]

Irritation and fury are not the only threats to diseased coronary arteries. Nancy Frasure-Smith of McGill University believes that depression also seriously prejudices the chances of heart patients for recovery. Depression, in turn, can result from chronic uncontrollable stress, as well as from a previous heart attack. Victims often suffer from

(Men who explode with anger or expect the worst from people may punish their own bodies as well.)

a considerably higher risk of heart attacks. In several additional studies, researchers sought a comprehensive evaluation of Friedman and Rosenman's belief; they were not able to provide confirmation. Yet the aggression and hostility exhibited by Type As contribute to higher levels of stress and its deleterious effects. And although Type As do not necessarily have an increased lifetime risk of having a heart attack, their short-tempered, impatient behavior makes it more likely that they will have a heart attack sooner, according to a study in the May/June 2003 issue of *Psychosomatic Medicine* by John E. J. Gallacher of the University of Wales College of Medicine.

Many top executives may be Type As, but simply being a Master of the Universe does not raise the risk of heart attack, perhaps because those at

inner hopelessness, such as fears of being unable to meet challenges in their work or personal lives. And loss of a beloved and trusted partner can literally break someone's heart: as long ago as 1969 Colin Murray Parkes, a British doctor, showed that widows and widowers suffered greatly increased mortality.

Looking on the Bright Side

As the work with the pigs showed, the frontal brain seems important in fibrillation and apparently is connected to the nerve cell bodies of the sympathetic nervous system in the spinal cord. Through this connection, the human mind ought to be able to influence heart function in a positive manner. Relaxation techniques such as autogenic training may possibly utilize this mechanism.

Mental Illnesses

According to current scientific thinking, the following disorders are among those believed to be at least partially caused psychosomatically:

Gastrointestinal system: Eating disorders (anorexia, bulimia, psychogenic obesity), constipation, irritable bowel syndrome, gastric ulcers

Cardiovascular system: High blood pressure (hypertension), syncope (fainting spells), cardiovascular heart disease, arrhythmia, heart attack

Airways: Asthma, nervous cough

Psychosomatic pains: Headaches, abdominal pains, soft-tissue rheumatism, certain muscular pains (myalgia)

Ear, nose and throat: Dizziness, hearing problems, tinnitus, swallowing problems

Endocrine system: Diabetes, psychosomatic dwarfism

Reproductive system: Male dysfunction, menstrual cycle disturbances, false pregnancy

Skin: Neurodermatitis, psychogenic pruritus, possibly psoriasis



Along with targeted stress management, such methods may improve the survival chances of heart patients more than daily exercise, as suggested by James A. Blumenthal of the Duke University Medical Center in 1997.

Psychotherapy's positive influence on bodily processes is especially evident in studies of pain patients. Neuropsychologist Pierre Rainville of the University of Montreal set up a therapeutic study based on suggestion, called guided imaging. Using positron-emission tomography (PET) imaging, he discovered that a brain region responsible for the conscious awareness of pain, the anterior cingulate gyrus, would become less active—merely because of spoken words.

Another means to break free of the self-reinforcing cycle of heart disease, stress and depression is cognitive behavioral therapy. Patients learn to give more weight to positive events in their lives than to negative ones [see "Treating Depression: Pills or Talk?" by Steven D. Hollon, Michael E. Thase and John C. Markowitz; SCIENTIFIC AMERICAN MIND, Premier Issue, 2004]. A strong social network, as well as contact with trusted individuals, helps people to overcome stress, too. Heart disease patients who are married or in stable relationships have longer average life expectancies.

Two other important ingredients to reversing cardiovascular disease are developing more healthful eating habits and exercising regularly. Dean Ornish and his colleagues at the University of California at San Francisco tracked the progress of patients with coronary artery disease who ate low-fat vegetarian diets and got regular exercise. The subjects stopped smoking, and they sought to bring calm to their lives through stress management training and group therapy. After a year, the condition of their coronary arteries had improved noticeably.

Is the power of the brain supreme when it comes to affecting physical well-being, or does the body's health sway our mental states? Both usually go hand in hand: body and mind are bound up, inseparably, in a continual feedback loop. The scientific knowledge gained in recent years teaches us that just as corporeal phenomena can change our minds and spirits, it works in the other direction as well: thoughts and emotions can cause real changes to our bodies.

(Further Reading)

- ◆ **Why Zebras Don't Get Ulcers.** Robert M. Sapolsky. Henry Holt and Company (Owl Books), 2004.
- ◆ American Heart Association Web site is at www.americanheart.org





ADRIAN NEAL Stone Getty Images

Companies spend billions on marketing campaigns, but neuroscientists could someday determine which ads best capture consumers' attention

BY ANNETTE SCHÄFER

Have you ever been surprised at yourself after reviewing what you brought home from a shopping spree? Perhaps you bought a certain brand of chocolate only because a television ad for it showed warm tropical beaches and palm trees. Or you purchased an overpriced pastry at a bakery because it somehow reminded you of a treat from your childhood. Maybe you sprang for an electronic gadget you knew you didn't need just because your colleagues already have it.

Emotions, memories, herd instincts and other intangibles all influence our buying decisions. And none of these factors involves the classic cost-benefit analysis we generally pride ourselves on: that we won't buy something unless what we get seems worth what we must pay. What is going on inside our heads when we make such decisions? Marketers would certainly like to know. With modern neurotechnology, they are beginning to find out.

A Matter of Taste

Neuroscientists around the world are assessing why we respond to certain product advertising. Early investigations have examined traditional beliefs such as the one that macho imagery sells cars to men. Henrik Walter, a neurologist and psychiatrist at University Hospital in Ulm, Germany, showed 66 black-and-white photographs of sports cars, sedans and small cars to 12 young males while mapping their brain activity with functional magnetic resonance imaging (fMRI). The scans showed that a brain structure called the nucleus accumbens was significantly more active when the men viewed the sports cars. This tiny region is a center for self-reward. It is activated by the signaling molecule dopamine and releases endogenous opiates—substances linked to lust and pleasure.

Usually the nucleus accumbens is active when it receives signals that are important to survival—for instance, sexual stimulants or the prospect of food. Even a huge car fan would not claim that a Ferrari is critical to survival, however, so why does seeing such a vehicle trigger the release of dopamine? Because the object is one of perceived desire. Advertising has taught men that powerful sports cars are highly desirable.

Walter's study, part of work he is doing for DaimlerChrysler, is just one of a growing number designed to probe how we react to advertising and therefore how marketers might tailor their ads to

Automakers may use brain scans to determine which sports cars trigger the biggest release of dopamine in male buyers' heads.



target buyers. In the future, carmakers could ostensibly test which models or design variations within a model prompt the strongest emotional response. Indeed, General Motors and Ford, not to mention Camelot, the U.K.'s national lottery operator, have begun to examine how neurological surveys could augment traditional market research.

So far most so-called neuromarketing studies have used fMRI, which shows how metabolism changes in various brain regions. Perhaps the most notable test was a 2004 exploration by neuroscientist P. Read Montague of the Baylor College of Medicine and his colleagues. Montague turned the fMRI machine on one of America's most classic brand-name duels: Coke versus Pepsi.

For years, marketing experts have wondered why Coca-Cola remains the best-selling cola even though its archrival, Pepsi-Cola, triumphs regularly in blind taste tests. Montague invited 67 participants to help him find an answer. Subjects were given unlabeled samples of each beverage

while inside an fMRI scanner. Both sodas did about equally well. Both drinks elicited strong but similar reactions in the ventral putamen, a brain structure believed to be the registry of satisfaction.

Montague then repeated the test but identified the samples as Coke or Pepsi. This time three quarters of the participants stated that Coke tasted better. The fMRI images showed that while the ventral putamen had still been activated equally by the two brands, when participants were told they were drinking Coke they also showed heightened activity in the medial prefrontal cortex. This region is linked to complex thoughts, evaluations and self-image. Obviously, impressions associated with Coke overpowered the primary taste sensation. Montague concluded that Coke's long-term advertising had succeeded in getting cultural messages to affect areas of the brain that influence personal preferences.

Herds and Memory

That men favor sports cars and cola drinkers favor Coke is not news. So what does neuromarketing bring to the party? Objectivity—proof of a mechanism that links stimulus and effect. For decades, companies have employed traditional market research tools in their attempts to determine why customers prefer one product over another: standardized questionnaires, individual interviews with open questions, and focus groups of potential buyers. The problem with these methods is that they rely on participants to describe their motives in words and to do so without bias. But not every cola drinker knows what drives her to her favorite drink, nor can she objectively describe the impulse, given the bias of the marketing influence she has already been exposed to. Neuroscience's tools, in contrast, skip all emotion, introspection and ego.

These tools probe beyond the herd behavior of consumers, too. Gregory S. Berns, a neuroscientist at Emory University, asked 30 participants to compare 54 pairs of abstract three-dimensional figures and to decide if the paired items were similar or different. He also provided them with answers that he said other participants had given—some were correct, but some he changed to incorrect. The fMRI scans recorded during these tests showed that subjects who trusted the major-

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AFP/GETTY IMAGES (top); BILL PUGLIANO Getty Images (middle); BRYAN MITCHELL Getty Images (bottom)

ity's opinion more than their own had greater activity in the prefrontal cortex, where decision making occurs. They chose wrong answers more frequently, because they believed the rigged group responses. Individuals who stuck to their own analyses—and got more right answers—showed less activity in the same region.

Another team, led by Richard B. Silberstein of Swinburne University of Technology near Melbourne, Australia, examined why some advertisements remain in people's memory better than others do. Silberstein showed women a televised documentary that was interrupted several times by commercials and recorded their brain waves during the presentation. One week later he gave the women a memory test about the com-

brain areas that react exclusively to certain marketing stimuli. The idea that there is a specific "buying center" in the brain may be alluring from a marketing point of view, he says, but it is as wrong as the long-discredited phrenology thesis that a person's mental disposition can be understood by mapping the bumps on his or her skull.

To fully explain what is going on in a person's head as he or she watches a commercial or eats a chocolate bar requires an understanding of many different brain regions and how they interact. Neuroscientists can say little about this topic even for well-studied brain diseases, much less ephemeral phenomena such as reactions to ads. Neuromarketing faces practical limitations, too, nota-

(If companies can find out **what entices people,** then perhaps they will offer better products.)

mercials; the ads they remembered best were the ones that had triggered an unusually fast surge in the electrical activity of the left frontal lobe. Marketers could potentially use this finding to test prototype commercials—a strong surge could imply which commercial would stay in long-term memory.

The Neural Shopping Center

Neuroscientists are admittedly fascinated with such early results. Most of them caution, however, that conclusions are preliminary at best. Nevertheless, advertisers are proving impatient and are looking into how brain tests can enhance traditional market research. Some self-proclaimed neuromarketing experts also seem to be more interested in making money than in serious science. A few consulting groups already promise they can help potential clients build loyal, long-term relationships with their customers.

Walter says too many people are overestimating the power of brain scans. For one thing, he notes, the impressive, colorful images need careful interpretation. They do not directly reflect cognition; they are statistical analyses, and their predictive power depends highly on which statistical variables a researcher chooses to show.

Gerald Zaltman, professor emeritus at Harvard Business School and author of *How Consumers Think* (Harvard Business School Press, 2003), sees another danger: a widespread misunderstanding that it is possible to identify specific

bly the high cost of using a sophisticated fMRI machine for even a handful of research subjects. Distortion of results must be considered as well; individuals are not likely to react to a soda, hamburger or car when lying inside a narrow fMRI tube or when they have electrodes pasted to their heads in exactly the same way as they would when lounging on their sofa.

Still, given how hard corporations fight to find an edge for their product, researchers such as Walter imagine that imaging technologies will probably become standard tools for assessing marketing strategies. Silberstein adds optimistically that the trend could even benefit consumers: if companies can indeed find out what entices people, then perhaps they will offer products that will better satisfy customers. Neuromarketing has also drawn criticism from some consumer advocates who worry that the technique could lead to manipulative strategies by corporations—a modern-day equivalent of the subliminal messages discovered in movie reels of the 1950s. But Montague takes an optimistic view: studies like his on Coke and Pepsi could actually empower consumers by making them aware of their susceptibility to advertising messages and images.

(Further Reading)

- ◆ **There's a Sucker Born in Every Medial Prefrontal Cortex.** Clive Thompson in *New York Times*; October 26, 2003.
- ◆ **Reading the Consumer Mind: The Age of Neuromarketing Has Dawned.** Douglas Rushkoff in *NyPress.com*; February 2004.

Stopping the BULLIES

**School can be torture for children
who are targeted by abusive students**

By Mechthild Schäfer

The boys attack Basini almost every night, yanking him out of bed and pushing him up the stairs to the attic. No teacher will hear his screams there. They force him to undress, then whip his back. Naked and defenseless, the boy cowers while his tormentors force him to cry, "I'm a beast!" During the day other students surround him in the school yard and shove him around until he collapses, bloodied and soiled.

Robert Musil's *The Confusions of Young Törless*, a fictional study of puberty in a turn-of-the-century Austrian boarding school, was pub-

lished in 1906. The impulses that seethed behind the walls of the Imperial and Royal Military Academy may sound like embarrassing relics of a bygone era, but they are not. Raw violence by a group against one individual, covered up by fellow students and avoided by teachers, still happens in schools today. And bullying in general—physical and psychological intimidation and humiliation, as well as the regular spreading of rumors—is more pervasive than communities, school officials or parents would like to believe.

Unfortunately, it has taken shocking violence

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to focus more attention on solving the problem. The 1999 shootings at Columbine High School in Littleton, Colo., were a fatal attempt to strike back by two outcasts who had been bullied by popular jocks at the school. Bullying was one factor that drove Jeffrey Weise into a life of isolation before he went on a retaliatory shooting spree at Red Lake High School in Minnesota in March, killing nine others and then himself. And every year adolescents commit suicide, leaving behind notes like that from a 14-year-old Canadian girl: “If I try to get help, it will get worse.... If I ratted,

there would be no stopping them.” Schools must take more aggressive steps to stop the torment, and the most fundamental measure is to better understand what motivates bullies in the first place.

Systematic Abuse

Psychologists and behavior researchers have only seriously studied mobbing—group bullying—among students since the beginning of the 1980s, led in large part by Norwegian psychologist Dan Olweus of the University of Bergen. In

his pioneering study of Swedish and Norwegian students, Olweus concluded that children can be very skilled in systematically using their social clout at the expense of weaker schoolmates. The goal is to enhance their own position.

Mobbing thrives in hierarchical settings because they allow dominance and strength to reign as the measure of an individual's social value. It is therefore not surprising that prisons and military bases, with their emphasis on rules and rank, are often the scenes of mobbing. Schools, in which older or stronger children can lord their age and power over younger or weaker ones, share similar traits. Thrown into a diversity of personalities, certain individuals try to create a social structure that confers on them an advantage. And usually that power is wielded to abuse others.

According to the National Center for Education Statistics, in 2003 some 7 percent of U.S. students ages 12 to 18 reported that they had been bullied at school in the past six months. (And certainly far more never said a word.) The likelihood

of bullying was highest in the younger grade levels: 14 percent of sixth graders, 7 percent of ninth graders and 2 percent of 12th graders reported that they had been picked on. A 2001 study by the Kaiser Family Foundation and Nickelodeon found that 74 percent of eight- to 11-year-olds reported the existence of bullying at their school; 86 percent of 12- to 15-year-olds also noted bullying.

Sufferers must usually face the harassment alone. Other boys and girls generally take the side of the perpetrators, fearing that they could be next in line. Or they pretend events did not happen and keep their mouths shut. Few find the courage to stand up for their fellow students. In the end, mobbing affects the entire school atmosphere, not just the bullies and their targets.

Power-Hungry Predators

To learn about what motivates the abusers, a research team (of which I was a part) at the University of Munich conducted a long-term study of 288 second and third graders from different

Young bullies often have had tougher physical discipline from parents and viewed more TV violence.

Intimidation can be psychological as well as physical, through taunting, gossip and the regular spreading of rumors.



BANANA STOCK/AGE FOTOSTOCK

elementary schools in southern Germany. We questioned them about their experiences: What kinds of children were apt to fall prey to bullies? How did the rest of the class react? We interviewed the same children six years later, when they were in the eighth and ninth grades. We asked if former victims were still targeted. And we asked how victims dealt with such problems now that they were teenagers.

Our first important finding was that bullies can be identified early in elementary school: even at a tender age, they are able to organize a mob against certain individuals. They appear to always be on the lookout for new kids to pick on. And they find it difficult to abandon their roles over time; perpetrators tend to remain perpetrators over many months and even years.

Bullies are usually very dominant children who have learned early on that they can become the leader of a group by being aggressive. Their modus operandi is to humiliate a student who is physically or psychologically susceptible to rise to the top of the social order. They try to force others to kowtow to them by acting tough, and other children may oblige simply out of fear. Often the bullies have learned about the power of aggression at home. Researchers at the University of Arizona who studied more than 500 middle school students found that the children most likely to engage in bullying had experienced more forceful physical discipline from their parents, had viewed more TV violence and had fewer adult role models. To a degree, they had learned by example.

Likewise, we encountered eight-year-olds who, by their own statements and those of their contemporaries, had been the butt of mobbing for quite a while. They endured harassment and exclusion yet never put up resistance or informed adults about their situation. The consequences can be long-lasting. In earlier studies we had shown that children who are harassed by schoolmates over a lengthy period are often unable to defend themselves against hostility and react to attack with anxiety and helplessness. Such terrible experiences make it all the more likely that they will fall into the traps set by bullies.

When we asked the same questions six years later, the students' answers bore this out. After asking the 13- and 14-year-olds which kids they liked and which they did not, we developed a preference profile that gave us a good sense of an individual's social ranking in a class. The result was surprising. In contrast to the bullies' relative lower standing during elementary school, they had actually become very popular with their

Is Your Child a Victim?

Most children will not tell their parents if they are being bullied, because they are afraid that their parents will somehow blame them or that word will get out that they "told" and the bullies will heap even more abuse on them. But parents can look for certain suspicious indicators:



- Unexplained reluctance to go to school.
- Fearfulness or unusual anxiety.
- Sleep disturbances and nightmares.
- Vague physical complaints, such as headaches or stomachaches, especially on school days.
- Belongings that are "lost" or come home damaged.

If you suspect your child may be a victim, do not ask him or her directly. You might ask your child such questions as: What goes on during lunch hour? What is it like walking to school or riding the bus? Are there any children who are bullies?

Be a good listener. Allow your child time to explain how he or she feels. If you suspect your child may be a victim, state clearly that it is not his or her fault. Then ask yourself if the events are serious enough to discuss with a teacher, principal or even the police.

By Sarah Shea, associate professor of pediatrics at Dalhousie University in Halifax, Nova Scotia. Adapted from "Parents' Primer on School Bullying," by Richard B. Goldbloom, in Reader's Digest Canada Online, March 9, 2005.

classmates. Their victims, on the other hand, got few sympathy points.

How do certain students get selected, abused and finally rebuffed by many of their peers? Are these children disliked because they are mobbed, or are they mobbed because they are disliked? It seems both dynamics are at play. Even if the victims were able to avoid some of the bullying when they were younger, school often became some-

(The Author)

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Former victims more frequently have trouble forming trusting relationships with other adults.

thing of a torture chamber as they got older. Their peers acted as if they were not there or responded with outright rejection and whispered behind their backs. The bullies escalated this game, insulting and making fun of them. Many of the target children came to identify with the underdog role and became the playthings of whoever persecuted them. And the longer the intimidation went on, the more the loyalty of others was lost.

This dynamic is aggravated by supposedly disinterested bystanders, an insight explored in depth in the early 1990s by Canadian psychologist Debra Pepler. After questioning students about mobbing, she and her team shadowed them with hidden cameras and microphones. The researchers discovered that almost 60 percent of the supposedly neutral students were on friendly terms with

the bullies. Almost half the “uninvolved” observers eventually graduated to jeering the victims and egging on the perpetrators. Numerous other studies have demonstrated that a large majority of students eventually go along with the bullies or become perpetrators themselves.

Helping the Victim

Further understanding of what makes bullies prevail will help break down their sources of power. In the meantime, though, more should be done to minimize the long-lasting effects on those who are hurt. In 2002 my colleagues and I interviewed 884 men and women from Germany, the U.K. and Spain, more than 25 percent of whom recalled having suffered physical and psychological attacks by other children when they attended school. Their bitterness at being excluded

Stopping the Bully

By not showing weakness, a child can lessen chances that a bully will target him or her. Some tactics for encounters:

- Stand straight and tall; look the bully straight in the eye.
- Be polite but firm. Tell the bully, “Stop it” or “Leave me alone.”
- Do not cry or show that you are upset. Walk away if you cannot hide your fear.
- Report events to a trusted adult.

Parents can help children who have been bullied at school in these ways:

- Contact your child’s school anonymously and ask if it has a policy for handling bullies.



- If assured that an inquiry will not expose your child to greater risk, inform the school of specific events that transpired, including date, time and place.
- Follow up with school administrators. Ask what action has been taken

and how your child will be kept safe if his or her identity is accidentally exposed.

By Cindi Seddon, principal of Pitt River Middle School in Port Coquitlam, B.C., and co-founder of Bully B'ware Productions.



Students often side with the perpetrator, look away during confrontations or pretend events did not happen, fearing they could be next in line.

ed and threatened continued to affect them in their adult lives. Former mobbing victims more frequently had trouble developing trusting relationships and lacked confidence when interacting with other adults. Their expectations of themselves and others were lower than average. The one positive note was that their previous experience was not usually repeated in their work lives, although mobbing in the workplace—the ganging up of subordinates or superiors through rumor, innuendo, intimidation, humiliation, discrediting and isolation—does happen.

The long-term consequences of mobbing make clear that early prevention is critical. The tricky task of intervening at the right moment falls to teachers and parents—who may not be prepared to act appropriately. For example, Norwegian students told a government ombudsman that adults do not even recognize their predicaments in the classroom. Our team's work bore this out: on questioning, teachers admitted to feeling unable to make sense of complex student relationships.

Nevertheless, at a minimum teachers can set standards by their own behavior. How they act in their position of power has an effect on the students. For example, they should avoid all derogatory comments and never return homework

in descending grade order. Weak students should not be criticized in class. If a teacher makes it clear that he or she is there for all the students and treats each one alike, they will see this as a sign not to exclude others from the group.

The subject of mobbing certainly belongs in the curriculum, too—perhaps in combination with antiviolence training or special projects. Another way to improve how students deal with one another socially is to appoint student mediators who can help resolve conflicts in a class of students. Initiatives such as these promote cohesion within the group so that bullies find it more difficult to undermine the school community by singling out and accosting its weaker members.

In Musil's story, the young Basini found no help. The three perpetrators went unpunished. The other students covered for the bullies, and the teachers were caught in a web of lies, charges and countercharges. In the end, Basini was expelled. Real life for a real victim can be much worse.

(Further Reading)

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- ◆ **Indicators of School Crime and Safety: 2004.** National Center for Education Statistics, U.S. Department of Education, Washington, D.C.

A group of happy people exits the lobby of the Luxor Hotel and climbs aboard a sightseeing bus, excited to begin a second day touring Las Vegas. The men and women chat and laugh, poking fun at one another about events that happened the night before. But it is remarkably quiet. Only their hands are moving as they look at their partners, their faces and body positions emphasizing their words. The other passengers on the bus sit there awkwardly, surprised to be excluded from the energetic conversations. It is then that they realize how deaf people must feel when they are among those who hear.

Every aspect of verbal communication is possible with sign language: expressing joy, conveying anger, telling tales, trading jokes. The discourse follows the same logical principles as spoken language. Yet it has its own syntax, semantics, rhetoric and irony, which involve far

SiGnInG

Gets a Scientific Voice

Sign language is as rich and complex as spoken communication, probably because the brain creates and deciphers it in the same way

more than just the position of fingers on a hand: hand gestures, facial expressions and body postures all add to the repertoire. Furthermore, just as Spanish differs from Swahili, and American English differs from common English in Britain, American Sign Language (ASL) differs from Danish Sign Language and also from British Sign Language. Sign languages even have their own dialects and accents, analagous to a Bostonian's clip or a Texan's drawl. There is sign poetry, and there are even a few sign choirs.

More than one million Americans are completely deaf, but their communication is rich in complexity. ASL is said to be the fourth most common language in the U.S. For decades, however, the hearing world looked on sign language as a kind of pantomime and often ridiculed the people who used it. Only recently have linguists learned to appreciate sign language's own intricate grammar. And only more recently have neuroscientists begun to determine how the brain handles the task. The surprise is that sign language is processed by the same brain regions that understand and generate spoken language, even though

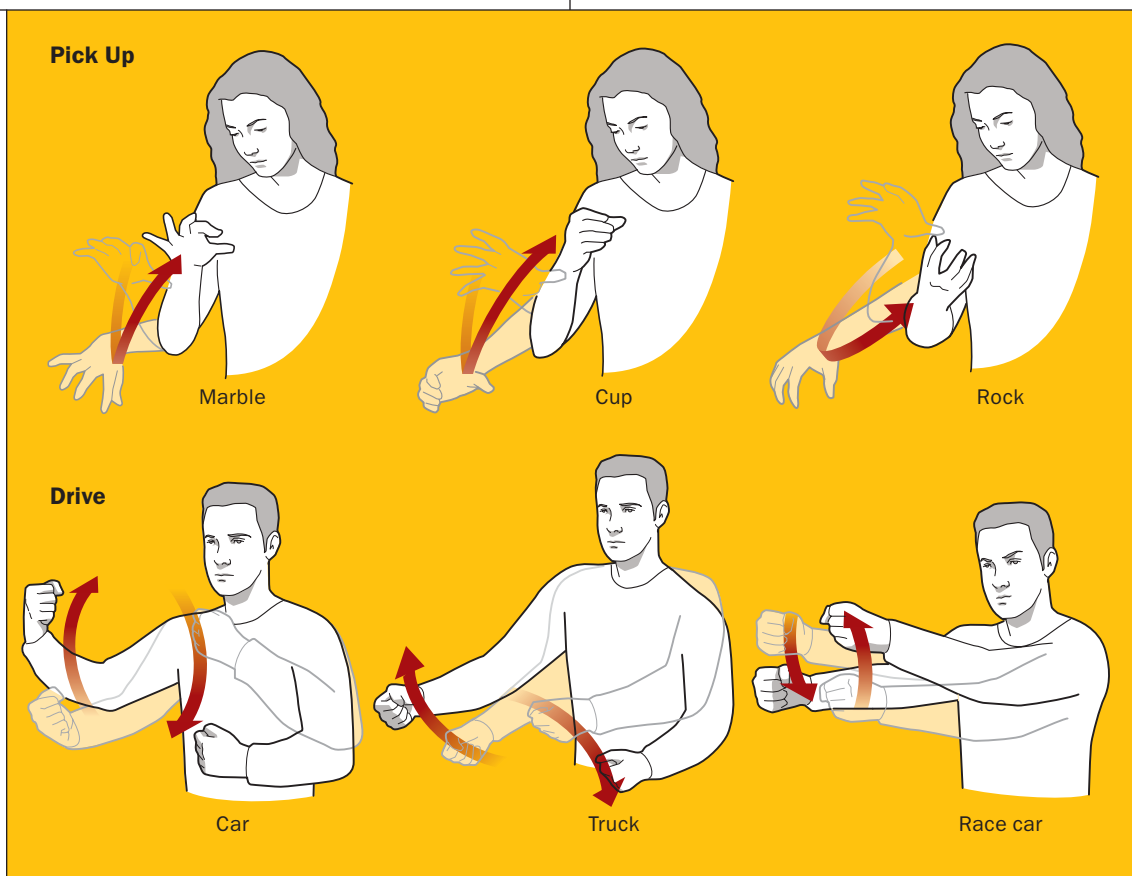
American Sign Language medley: interpret, join (left to right, top); share, vote (middle); college, people (bottom).

PETER STEINER Corbis

BY JENS LUBBADEH



The hand shape for “pick up” differs according to the object being grasped (top). Posture and expressions matter, too: although the hand motion for driving a car (bottom) is similar for other vehicles, lowering the arms or furrowing the brow specifies a truck or race car. (All depictions are American Sign Language.)



vision and hand movements are used in one format, and hearing, vocal cords and lip movements are used in the other.

Cultural Suppression

For a long time, brain scientists did not bother to investigate sign language, because they adhered to the same false assumptions made by the general public. Chief among them was that sign gestures were merely primitive, symbolic attempts to represent objects or actions—substitutes for spoken words. That misconception in turn led to the supposition that the same sign language was used throughout the entire world—if a country allowed one to develop at all.

Social and even political repression of deaf people was incredibly strong during the 1800s and much of the 1900s. In Germany, for example, German Sign Language was banned in schools for the deaf right up to the 1980s. This was perhaps the most extreme case of a trend that had held sway across Europe for a century—that deaf people, supposedly for their own good, should be integrated into the hearing community. Preference for this “oral method” meant that schools, and society in general, suppressed the use of sign language.

The outcome was horrible for deaf students.

Because they received no feedback from their ears, they could not control the sounds they made with their mouths nor improve their speech through practice. Learning to talk was torture, success was limited, and the upshot was that little other learning took place. Students who graduated from schools for the deaf were condemned to menial jobs, and some were treated as though they were mentally retarded. Without their own linguistic culture, they lost most of their ability to communicate with others, which eroded their self-esteem and blocked almost any chance for social or economic advancement.

Similar patterns took place in the U.S., with scattered periods of self-determined advancement by deaf people alternating with the hearing world’s imposed agenda. The damage from this paternalistic treatment runs deep; even today it is not uncommon for average people to look on their fellow citizens who are deaf or mute as somehow inferior.

Yet the U.S. may have subtly benefited from Europe’s heavy-handedness. One linguistic expert and educator decided to leave his continent and show the world what could happen if sign language was indeed allowed to develop. In 1816 a French teacher named Laurent Clerc emigrated to America and soon co-founded the country’s

Screening for deafness early and exposing deaf infants to sign language will help them lead full lives.

first school for the deaf, in Hartford, Conn., with Thomas Hopkins Gallaudet. Clerc began teaching French Sign Language (FSL) to Americans, who mixed it with the more rudimentary forms of local, natural sign language they had cobbled together. Although cultural prejudice prevailed, the language did grow. Today's ASL is unique, yet it is far more "French" than spoken American English is. Modern ASL and FSL share a substantial amount of vocabulary and certain grammatical conventions, and yet they are not both understandable by a person who has been trained in only one of them.

It is not surprising, then, that the sign languages and spoken languages native to any given country have developed very differently; they often have radically divergent histories. ASL and British Sign Language differ far more than spoken American and British English do.

Grammar in Hand

Although it is true that the deaf community uses a few signs that "look" like the item they describe, the vast majority of signs are abstract and conventionalized. Some signs have changed throughout their usage, and new ones are emerging today—the same phenomena that drive spoken languages.

As linguists finally began to appreciate the multifaceted nature of sign language, they began researching its conventions. And as they found many traits that were similar to those of spoken languages, neuroscientists began to wonder if the brain processed the two forms of communication in similar ways [see top box on next page].

In some sense, sign languages are more complex than spoken languages. Anyone who speaks English or Danish or Swahili links one sound to another, building syllables, words and sentences. The formation is linear. Sign languages, however, function in three dimensions. A hand is held in a particular position while the fingers create a specific "hand shape." Each dialect has a catalogue of hand shapes, just as each spoken language has an inventory of phonemes. But in addition to hand shape, there are hand motions, facial expressions, shape of the mouth and movement of the entire body. All these facets operate simultaneously. Using a single verb gesture, a signer can deliver three, six or even nine different items of informa-

tion. Visual patterns are the bearers of meaning.

For example, the spoken word "toast" contains the sounds for "t," "oh," "s" and "t," which can deliver that meaning only when they are in that order. Deaf signers do not use just a finger alphabet but (in ASL) express the concept of "toast" by forming a V with the first two fingers of the right hand, touching it to an upturned left palm, and then circling it down to touch the back of the left hand. Taking away part of a sign, or replacing it with another element, creates a different word. Touching the same V to the right cheek and twisting it inward means "vegetable." Changing the movement by holding the V in front of the chest and squeezing the two fingers together gives the sign for "cut."

Space Adds Speed

Many sign languages also utilize spatial dimensions to express the relations among subjects and objects in a sentence, interactions between persons, and many other grammatical and content concepts. Objects can also be merged with verbs. For example, the ASL sign for "pick up" changes according to its object: picking up a marble, a cup or a stone is portrayed in different ways.

Variations in gesture also deliver information about an object's qualities or a movement's details. Denoting a large book versus a small one is done with the extent of hand movement when making the sign for "book." In some ways, spoken language cannot express as much. Saying "I stood on the bed" provides no information about which leg you are standing on, which side of the bed you are on, or how quickly you stood up. This can be accomplished in one movement using sign language. These differences can sometimes make it difficult for translators to convey spoken dialogue in signs, or the other way around.

Interactions with people are also presented spatially. In many languages, including ASL, a signer defines a point near her body as the standing position of a person she is talking about, and the signs about that person will be presented there. For the sentence "Emily visited Nick," the

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Same Brain for Speech and Sign

How does the brain process sign language? In the 1980s neuroscientist Ursula Bellugi of the Salk Institute for Biological Studies in San Diego made some of the first attempts to answer that question. It had been well established that Wernicke's region of the brain was largely responsible for understanding speech and that Broca's region was the main player in the production of words and sentences. Bellugi studied deaf subjects with injuries to many different brain regions.

Some patients seemed to suffer from symptoms comparable to Wernicke's aphasia—they could sign fluently but had trouble understanding signs from others. Bellugi found that they indeed had damage in Wernicke's area. Other patients had difficulties that paralleled Broca's aphasia—they struggled to form sign-language hand positions even though other fine-motor skills posed no problems. Sure enough, Bellugi found lesions in their Broca's area.

The work by Bellugi and others provided evidence that although signing uses completely different sensory chan-

nels—vision instead of hearing—it is processed in the same brain regions.

Neuroscientists have since concluded that certain parts of the cerebral cortex are reserved for language processing, no matter what sensory channel brings in the linguistic input. For many researchers, this finding was evidence that the ability to speak is innate. People are born into the world with a speech center and then learn one or more tongues, whether they are English, Japanese, American Sign Language (ASL) or French Sign Language.

Recent observation of a secluded group of deaf children in Nicaragua supports this thesis [see *box below*]. The children were never taught any sign language and had therefore simply created their own, and it had grammatical structures that were strikingly similar to those of spoken languages.

Further research has delved into whether the left or right hemisphere of the brain is dominant. The answer had been hard to determine until the advent of functional magnetic resonance imaging allowed scientists to more or less

signer will define one spot for Emily and another for Nick. The Emily spot will then symbolize that person for the rest of the story. To sign "Emily visited Nick," all the speaker needs to do is make the sign for "visited" and move it from the Emily spot to the Nick spot.

In this way, sign language can be very economical. Instead of filling each sentence with redundant information by repeating "Emily," "Nick" and "I"—as many spoken languages re-

quire—space takes over this grammatical function. Such traits help sign language overcome one of its main disadvantages: hands cannot "talk" as fast as mouths can speak.

Spatial orientation also means that signs may acquire certain meanings in context. For example, it could be difficult to break into a short video clip of a signer in the middle of a story and be able to follow what was being conveyed. In some ways, sign language and its narratives may be more closely intertwined than is the case with spoken or written language.

Innate Language

A group of deaf children discovered in Nicaragua grew up having little contact with other people but developed their own abstract sign language that had grammatical structures similar to those of spoken languages. Their development suggests that language processing is innate to the brain and not learned after birth. Here one of the Nicaraguan boys (*bottom*) shows how a cat that swallowed a big ball would wobble down a path in a rolling manner. A boy who grew up in the presence of both sign and spoken language conveys the same scene in Spanish (*top*). —Mark Fischetti



Questionable Faces

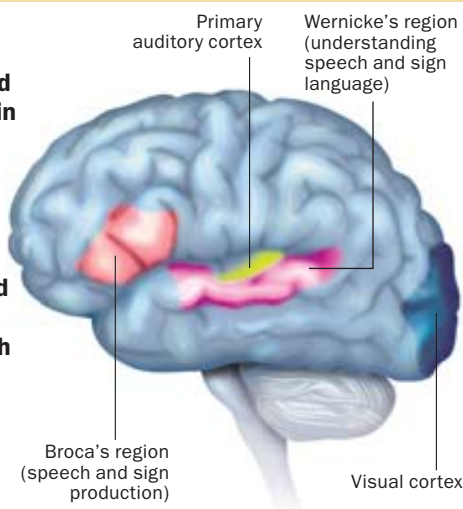
Facial expressions are just as important to grammar in virtually all sign languages. Many hearing people on seeing the animated faces of individuals who are signing mistakenly believe the people are expressing strong emotions. But facial expressions are much more than frosting on the cake. Without such mimicry, many signs are just wrong. For example, in ASL, an open right hand is thrust forward to indicate the future; the facial expression is neutral. But the same motion, made with puffed cheeks, means the distant future, and a wincing expression means the very distant future. Body language may come into play, too. The hand motion for "driving" a car is two extended hands moving as if they were turning a steering wheel. For driving a truck, the shoulders are tipped back and the head is pitched

ANN SENGHAS, 2004

watch the brains of signers in conversation. Using this technique, Helen Neville and Aaron Newman of the University of Oregon and David Corina of the University of Washington compared brain activity in three groups: people born deaf who had grown up using ASL, hearing people who had grown up speaking English and could not sign, and hearing people who had grown up with deaf parents and were raised bilingually with English and ASL.

All the subjects were presented with sentences in written English and with videos of signers presenting sentences in ASL. The right hemisphere was hard at work among the deaf subjects but did little for the hearing people who did not know ASL—for them the left side dominated. Yet the right hemisphere was highly active in the subjects who were bilingual in oral and sign language. This result suggests that the activity in the right hemisphere is characteristic of sign language itself and is not, for instance, a side effect of being deaf. Just what

Spoken words reach the primary auditory cortex and are then analyzed in Wernicke's region. Sign-language gestures are perceived by the visual cortex but are then processed in Wernicke's region, too. Speech and hand gestures are both produced in Broca's region.



the right hemisphere contributes to sign language is not yet clear, but researchers are looking for answers. —J.L.

upward slightly. Driving a race car involves a furrowed brow.

The changing intonation of a spoken question has its counterpart in sign language, too. ASL signers signal a question by raising the eyebrows and widening the eyes. They would ask a question of a specific person within a group by tilting their body toward that person while signaling with their eyes and eyebrows.

So-called sign markers complete the repertoire. For example, in ASL the written past tense ending “-ed” is conveyed by pushing a flattened right hand backward over the right shoulder.

Learn Early

Understanding sign language's intricacies makes it apparent that learning this form of communication may be as difficult as learning a foreign spoken language. That is why the old suppression of signing, especially in children, was so damaging and must never be repeated.

Fewer than 10 percent of all hearing-impaired children have two hearing-impaired parents. A deaf child born to deaf parents who already use ASL will acquire the skill naturally, just as a hearing child picks up spoken language. But households with one or two speaking parents must begin using and teaching sign language from a newborn's early days. As with any language, interaction between a baby and parents is vital to acquisition.

Hearing parents who do not know sign lan-

guage must learn it along with their child and should introduce it as early as possible. Research shows that the first six months of a child's life are the most crucial to development of oral language skills, and newer studies show the same applies for visual language. The earlier exposure begins, the more competent the child will become; tests indicate that native signers of ASL are consistently more accomplished than individuals who learned ASL later. Brain-imaging studies also show that people who have grown up speaking and later learn sign language process visual imagery somewhat differently from individuals who were raised with ASL from birth, suggesting that sign language enhances certain visual-processing functions.

All these insights, of course, mean that early screening for hearing loss should be routine. Discovering deafness early and exposing infants to sign language will help them lead lives that are full of conversation. The happy deaf people on the tour bus in Las Vegas were not merely communicating. They were demonstrating just how rich and unique their language and lives can be.

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- ◆ An online video dictionary of American Sign Language can be seen at <http://commtechlab.msu.edu/sites/aslweb/browser.htm>

Self-control helps you meet small challenges, but to change your life significantly you'll need self-regulation instead **BY MAJA STORCH**

Taking the Reins

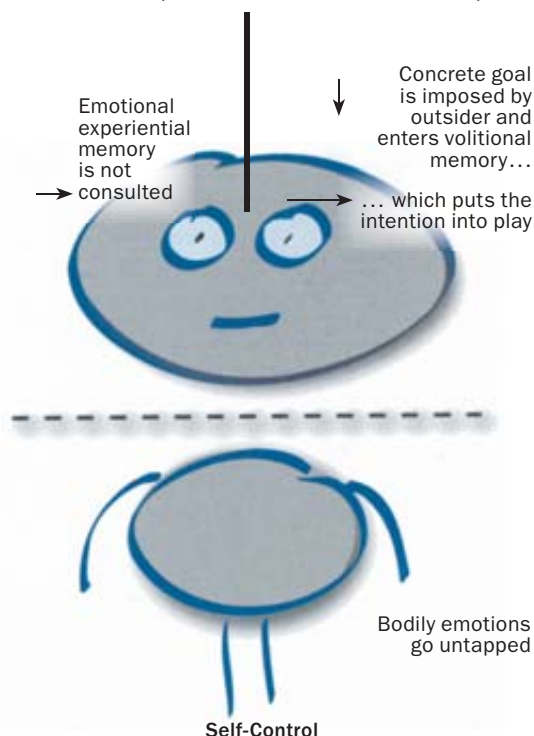
MANY PEOPLE HAVE grown up hearing the same exhortations: “Put your shoulder to the wheel!” “Pull yourself together!” “Shape up!” All these demands are aimed at the same thing: self-control. This ability is an essential life skill, yet it also has the obvious drawback of being stressful. It is hard enough for most people to force themselves to see a dentist for an annual checkup. Accomplishing a larger, longer-range goal can be so daunting that we often never confront it.

The reason we demur, psychologically, is that self-control does not give us enough sustained motivation to achieve big plans. For that we need self-regulation, something we do every day without realizing it. Understanding how to spot your own self-regulating mechanisms, and then how to exploit them, will give you greater power to reach your most prized objectives.

I Will Go Jogging

Our brains employ two forms of willful control. The first is volitional memory. It comes into play, for example, when Beverly, an architect, makes up her mind on Wednesday morning that at the upcoming Friday meeting, “I will voice my objection to the design of the new school’s facade.” Her volitional memory has to keep her intentions intact for two days. That’s not too hard, but not simple either; anyone who has ever said to herself,

“This weekend I will go jogging,” knows how hard it can be to keep that intention afloat. Beverly’s volitional memory has to inhibit her will to say



something before Friday and to see that she waits until the right moment at the meeting to most effectively interject her ideas.

Self-control is enough to accomplish this kind of task because the goal is very concrete, relatively short range and not overly demanding. But for loftier goals, our volitional memory tends to run out of gas. Resolutions evaporate as soon as we are under stress or are distracted.

For these challenges, we must engage the second form of willful control: emotional experiential memory. This function stores all experiences and evaluates them from an emotional perspective. In contrast to volitional memory, it operates unconsciously. Rather than posting a verbal idea in our conscious minds (“I have to wait until the meeting on Friday”), experiential memory makes use of somatic markers, emotions or physical sensations that inform us about a situation based on past experiences or feelings. Somatic markers include the churning in our stomachs when we are anxious, a flushing of the cheeks when we are embarrassed, wide-open eyes when we hear an idea that excites us, or a relaxation of body muscles signaling the relief we feel when we get something off our chest.

Self-regulation will not work for externally set goals, such as “Beginning tomorrow I will go on a diet because the doctor told me that being overweight is unhealthy” or “I want to work harder because then my boss will pay more attention to me.” These impositions go directly to our volitional memory, putting us into a self-control mode that simply cannot sustain the effort required.

To use emotional experiential memory, such goals have to be reformulated into more general targets that will evoke strong positive emotions in us,

(A Ph.D. student can resist friends’ invitations to carouse by envisioning **a rewarding life** as a professor.)

(A woman who wants to **lose weight** can imagine arriving at a party in a miniskirt, turning heads.)

such as “I would like to have an attractive, sexy figure” or “I would like to contribute more to this company project because I am excited about how it could turn out.”

Once such an internally generated, emotional goal is identified, experiential memory will provide the necessary motivation. It offers a tool kit of clever tricks. For example, it can influence the parts of the brain that are responsible for mood and general arousal.

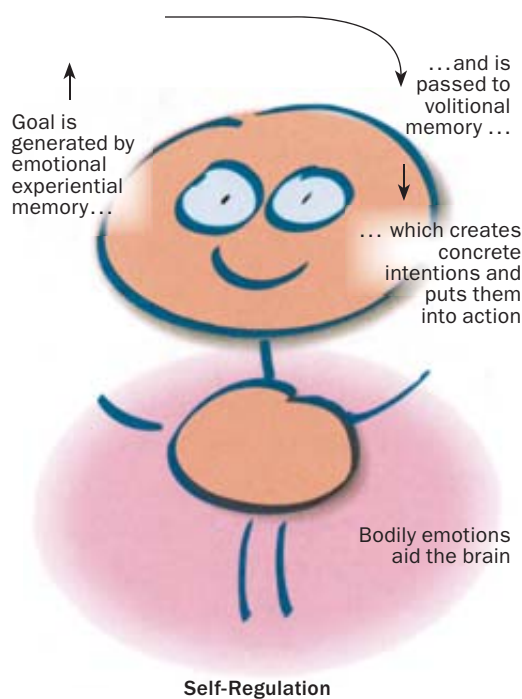
We can fuel the fire by creating in our minds an intense representation of the desired goal that draws on as many of the senses as possible. A woman who wants an attractive figure could imagine how she would arrive at a boisterous party wearing a miniskirt, attracting admiring glances from the men there—and perhaps even a little praise (or envy) from the women.

A doctoral student who is working on her dissertation can resist, more than occasionally, the invitations from her roommates to go to the beach or to go out drinking, because those events will delay the work she must complete to finally attain her Ph.D. This example highlights the difference between self-control and self-regulation. When the young woman’s intention to research her dissertation comes from her experiential memory, it will not harm her psychic health if she forgoes, even for a whole year, the pleasures her friends enjoy. Her feeling of satisfaction in creating what will be a fulfilling life as a Ph.D. will outweigh the disappointment of short-term sacrifices. If, on the other hand, completing her degree was based on nothing more than fulfilling the exhortations of her parents, she would have only self-control to drive her, and her emo-

tional experiential memory would constantly rebel.

Forging a Plan

The best way to learn the difference between self-control and self-regulation, and to figure out how to harness them to your advantage, is to train



yourself to be aware of your somatic markers. One tool is to keep a log for about four weeks. Carry a small notebook, and over the course of a normal day, record events that evoke negative or positive somatic markers. Note the time, date, event, type of somatic marker and some indication of why you think you felt that marker. For example:

Tuesday, June 14

6:45 A.M. Erika asks if I can pick up Timmy from day care this evening. Negative somatic marker (sinking feeling in stomach). Reason: time pressure because of my meeting with Mr. Lewis.

10:15 A.M. Dan comes into my office and invites me for coffee. Positive somatic marker (feeling of freedom). Reason: conversation might help me find a better way to solve the project analysis I’m struggling with.

This method will produce two kinds of information. First, it will identify recurring situations that you find annoying and that you can use self-control to adjust. But more so, it will give you an insight into the somatic markers that your emotional experiential memory taps into, which may be very different from those of the people around you.

After four weeks of such book-keeping, you will be aware of your somatic markers and find ways to use them. You should ask yourself: “How can I prevent situations that elicit negative somatic markers and increase the positive occurrences?” You could learn from your June 14 entry, for example, only to agree to pick up Timmy from day care when doing so does not conflict with a business appointment. In compensation, you could tell Erika you will bring Timmy to day care on certain other days.

A cautionary note: reconfiguring your daily life is a long-term project. Do not expect dramatic changes at once. But anyone can certainly find several points that could be attacked immediately. Begin with small changes, and then you can go for major alterations. Resolve to avoid snacks during the morning or to say yes to new assignments. Once you feel comfortable with these kinds of moves, you can consider a plan for grander prizes: permanent weight loss or a more rewarding career.

MAJA STORCH is a psychologist at the University of Zurich.

Psychotherapy may help the large number of impotent men for whom drugs such as Viagra are not the answer **BY OLAF SCHMIDT**

Talk It Up

ADVERTISEMENTS FOR anti-impotence drugs are everywhere. The brand name Viagra—the “little blue pill”—has quickly become a household word and for understandable reasons. Studies show that more than 50 percent of American men ages 40 to 70 experience at least occasional erectile difficulties, episodes that increase with age. Yet a little-acknowledged statistic is that pharmaceuticals fail to help from 25 to 33 percent of men with erectile dysfunction.

Are millions of males, and their partners, simply out of luck? Not necessarily. A variety of psychological treatments can overcome the mental triggers that often cause the sexual disorder.

Emotional Blocks

Every erection begins in the brain—the most important sexual organ. The brain stem emits nerve impulses that control erectile function. Yet parts of the limbic system that are responsible for learning and emotions also affect the signals. The nerve impulses make their way through the erection center of the spinal column to the erectile tissue of the penis, where they trigger a chain reaction in the membranes of vascular muscle cells. This chain reaction depends on a messenger molecule called cyclic guanosine monophosphate, or cGMP.

But the engine of desire works in reverse, too: an erection softens as soon as the enzyme phosphodiesterase begins to degrade the cGMP molecules. Viagra, and competing drugs

such as Levitra and Cialis, inhibits phosphodiesterase to help maintain the erection. An erection first needs to be triggered psychologically, however; without this impetus, the potency pills are of little help.

Although urologists often attribute erectile dysfunction to organic causes, in many cases the problem is in the mind. Failure to achieve an erection can result from an array of psy-

chological causes. Even a man in peak health can experience emotional blocks in bed. These kinds of incidents can in turn lead to a vicious circle. Fear that a husband cannot satisfy his wife's sexual desires, for example, can ruin all sense of play in lovemaking, creating an even greater chance of physical problems.

Pressure for sexual performance and potency is itself a large contribu-



An erection is **triggered psychologically**; without this impetus, the potency pills are of little help.

IMAGE SOURCE/AGE FOTOSTOCK

Exercises may include massage or relaxation; partners begin to **unlearn fear** and to take pleasure in contact.

tor to impotence, and this theme is pushed continually. Advertising is rife with sexually charged images and symbols, selling men everything from automobiles to razor blades and beer. Talk about “good” or “better” sex is also ubiquitous in the media, as if bad sex (whatever that means) were the best one could hope for without special effort.

The net outcome is that unrealistic sexual myths become anchored in adolescent psyches and self-perpetuate into adulthood: men end up scoring their sexuality by how often they can “do it” and for how long. There is no place for sensuality, much less weakness or fear.

As studies by the late sexual psychologist and popular author Bernie Zilbergeld demonstrated, most men with potency problems believe in such myths. Men also often overestimate the level of women’s sexual demands. As a result, as soon as sex is in the offing, a man is most likely to observe and assess the situation as if he were an outsider, rating what is expected and what he can deliver. Zilbergeld called this phenomenon “spectatoring.”

Another psychological cause of impotence is stress, but not as the media typically portrays it. The image of the overworked executive who goes soft in bed is a bad cliché. If a man who is exasperated at his job has trouble achieving an erection—say, the night before a very important business meeting—the problem is seldom the work stress itself. Instead he is usually transferring to his sex life the pressure to perform that he feels generally in his business life. This turns the love act from a dance of desire into a grueling job that must be completed—and completed well.

Relieving the Pressure

Sexuality is multidimensional, involving anticipation, desire, love and attachment. Psychological treatment



Not Just Pills

Impotence can result from psychological factors such as stress, fatigue, anxiety or depression. But even when it has a physical cause, which is often the case, medication may not be the best, or even a viable, option.

Ailments that can trigger male impotence include heart disease, high blood pressure, hardening of the arteries, smoking, alcoholism, diabetes and the side effects of various prescription medications. Most of these conditions cause impotence by reducing blood flow or nerve impulses to the penis. Drugs such as Viagra work to increase blood flow, but a more long-lasting approach to improve a man’s sexual performance may be to improve the baseline condition that originally caused the problem. Furthermore, in many cases other treatments may be more effective, among them penile implants, vacuum erection devices, urethral suppositories and even injections.

The bottom line: consult a doctor about your circumstances and don’t expect to simply pop a pill.

strategies therefore vary with each person. Most therapists will begin with conversation to get to know an individual’s life circumstances, needs, hopes and worries. A treatment regimen might include 10 to 20 therapy sessions, along with partner exercises at home. These may involve massage or stroking in which both partners take turns, as well as simple guidance from the therapist about how they can unwind together. By doing these exercises, the partners begin to unlearn fear and to take pleasure in natural body contact.

Most treatments are not based on long-term therapeutic intervention. Some regimens are as short as one week, during which patients relearn how to relax and how to stay worry-free during sex. Exercise and other physical interventions short of drugs can also play a part; some plans may include deep-relaxation procedures and, as in hypnosis, may synchronize a subject’s breathing with words voiced by the therapist.

Other counselors will prescribe exercise sessions with machines that strengthen the pelvic musculature. A recently published study by urologist Frank Sommer of the University Medical Center in Cologne, Germany, showed that regular, targeted exercise improved the sexual potency of 80 percent of the men who tried it, compared with 74 percent of men treated with Viagra. Many men feel better simply because they have some kind of handle on the situation.

The success of sex therapy cannot be measured simply by whether a man regains his sexual potency—even though that is why most men seek treatment. A man who learns to live in harmony with his partner and not race through life pursuing a self-image as a sex machine has already taken a giant step toward a more satisfying sexual life.

OLAF SCHMIDT is a biologist and science writer in Duisburg, Germany.

The Animal in Us All

Animals in Translation: Using the Mysteries of Autism to Decode Animal Behavior

by Temple Grandin and Catherine Johnson. Scribner (Simon & Schuster), 2005 (\$25)

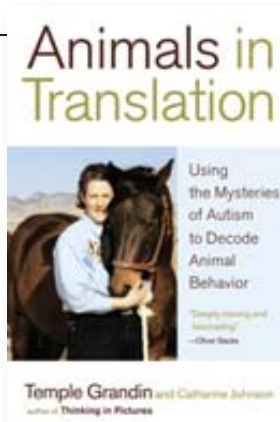
Temple Grandin has been known to crawl through slaughterhouses to get a sense of what the animals there are experiencing. An autistic woman who as a child was recommended for institutionalization, Grandin has managed not only to enter society's mainstream but ultimately to become prominent in animal research. An associate professor at Colorado State University, she designs facilities used worldwide for humane handling of livestock. She also invented a "hug machine" (based on a cattle-holding chute) that calms autistic children.

In *Animals in Translation*, co-authored with science writer Catherine Johnson, Grandin makes an intriguing argument that, psychologically, animals and autistic people have a great

deal in common—and that both have mental abilities typically underestimated by normal people. The book is a valuable, if speculative, contribution to the discussion of both autism and animal intelligence, two subjects on which there is little scientific consensus.

Autistics, in Grandin's view, represent a "way station" between average people, with all their verbal and conceptual abilities, and animals. In touring animal facilities, Grandin often spots details—a rattling chain, say, or a fluttering piece of cloth—that disturb the animals but have been overlooked by the people in charge. She also draws on psychological studies to show how oblivious humans can be to their surroundings. Ordinary humans seem to be less detail-oriented than animals and autistics.

Grandin argues that animals have



formidable cognitive capabilities, albeit specialized ones, whereas humans are cognitive generalists. Dogs are smell experts, birds are migration specialists, and so on. In her view, some animals have a form of genius—much as autistic savants can perform feats of memory and calculation far beyond the abilities of

average people. Some dogs, for example, can predict when their owner is about to have a seizure.

Delving into animal emotion, aggression and suffering, Grandin gives tips that may be useful for caretakers of pets and farm animals. She also notes that humans seem to need, and thrive on, the proximity of animals. Indeed, she states provocatively, in the process of becoming human we gave up something primal, and being around animals helps us get a measure of that back. —Kenneth Silber

Mind Reads

Killer Education

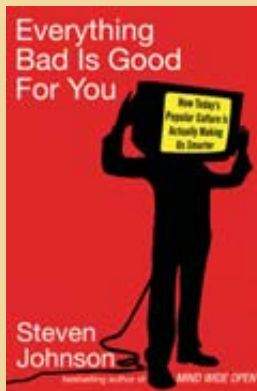
Everything Bad Is Good for You: How Today's Popular Culture Is Actually Making Us Smarter

by Steven Johnson. Riverhead Books, 2005 (\$23.95)

I am not a big fan of video games. Having watched friends devote weeks to slaughtering aliens in *Halo*, I have decided that time spent in virtual worlds is time wasted. It is just this kind of thinking that Steven Johnson tries to counter in *Everything Bad Is Good for You*.

A best-selling science writer who often tackles neuroscientific issues, Johnson argues against the presumption that popular media undermines our intellect. He claims that video games, television and movies are more complex than ever, to the benefit of viewers' cognitive skills. Whether we are mastering the intricacies of the simulation game *SimCity* or tracking the multiple plotlines in the TV drama *24*, we are "honing ... mental skills that are just as important as the ones exercised by reading books," Johnson writes.

The learning does not come from content but from form, Johnson says. Video games, for example, enhance our prob-



lem-solving and decision-making skills as we test the limits of a game's logic; the aliens we are blasting are secondary. After making similar arguments for television, film and the Internet, he proposes that this increasingly challenging media environment may help explain the upward trend in IQ scores.

Unfortunately, Johnson uses only a modicum of neuroscience to back up his thesis. Elsewhere, and in the absence of footnotes, his arguments lack rigor. It may be true that a child's zombielike stare at the TV set is a sign of focus, as he writes, but the positive implication inherent in this statement pales in the face of a large amount of research that links young children's excessive television viewing with attention, learning and social problems during childhood and teen years.

Johnson also addresses video-game violence with more opinion than science. Even though he maintains that content does not matter, he often underplays the violent objectives of popular games. I am not convinced that the cognitive skills derived from building a virtual city equal those gleaned from shooting cops and innocent bystanders. In the end, Johnson has persuaded me that perhaps some of what is bad is good, but certainly not everything. —Aimee Cunningham

Older but Wiser

The Wisdom Paradox: How Your Mind Can Grow Stronger as Your Brain Grows Older

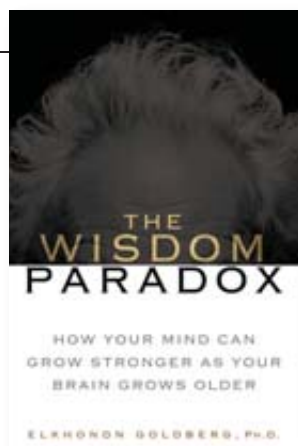
by Elkhonon Goldberg.
Gotham Books, 2005 (\$26)

The possibilities of cognitive decline and dementia are among the most frightening aspects of aging. But according to New York University neuropsychologist Elkhonon Goldberg, brains get better in key respects as they get older. Moreover, he argues in *The Wisdom Paradox*, people can do much to ward off the debilities associated with aging.

The brain's capacity for pattern recognition is central to Goldberg's premise. Moving through middle age and beyond, the brain develops a vast store of "generic memories"—knowledge of the shared patterns in events or things. This reservoir gives older people an improved ability to size up situations and solve problems without going through the step-by-step assessments a younger person might need.

Such pattern recognition underlies competence and expertise and can compensate for age-related declines in attention or memory. Pattern recognition can even amount to "wisdom"—basically, knowing what to do. The author cites various elderly achievers to demonstrate that mental vigor can persist late in life. He notes that sculptor Eduardo Chillida retained formidable abilities even as his Alzheimer's disease progressed.

Delving into the relevant neurobiology, Goldberg points to a growing body of evidence that the brain's left hemisphere is oriented toward familiar patterns, whereas the right hemisphere focuses on novelty. He argues that this dichotomy is more impor-



tant than nuts-and-bolts partitions, such as the left hemisphere handling language while the right handles spatial reasoning. This maturation of mind means that the left hemisphere becomes increasingly important over a person's lifetime.

Moreover, the brain is shaped by how it is used. For instance, musicians who practice consistently develop a larger Heschl's gyrus, an area involved in processing sound. And contrary to onetime scientific belief, the brain forms new neurons throughout adulthood.

Through such observations, Goldberg emphasizes the importance of maintaining an active mind as a defense against mental decline. Though not a new idea, Goldberg impressively fits it into a wide-ranging picture of the aging brain. He speculates, for example, that art serves a central societal function in boosting mental acumen. He also outlines a "cognitive exercise program" he runs in which participants engage in computer-based exercises. The discussion here would have benefited from home-based exercises readers might try.

Altogether, *The Wisdom Paradox* makes a compelling case for the possibility of maintaining a sharp mind far into old age. The book merits attention from the old and not so old alike.

—Kenneth Silber

Ice-Pick Therapy

The Lobotomist: A Maverick Medical Genius and His Tragic Quest to Rid the World of Mental Illness

by Jack El-Hai. John Wiley & Sons, 2005 (\$27.95)

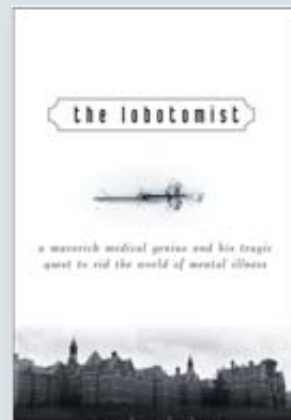
Few words conjure up more gruesome connotations than "lobotomy"—surgically severing the brain's frontal lobe in an attempt to relieve intractable psychiatric symptoms. And yet these operations—first performed in the U.S. in 1936 by psychiatrist and neurologist Walter Jackson Freeman and neurosurgeon James Winston Watts—continued for more than 40 years. In that time, Freeman, the procedure's champion, cut the brains of 3,500 people.

Biographer Jack El-Hai chronicles lobotomy's reign through Freeman's quest to treat mental illness surgically. The tale follows this son and grandson of prominent physicians from his youth in Philadelphia during the early 1900s through his rise and eventual fall in national prominence. Freeman emerges not merely as a maniacal devotee of radical "psychosurgery" but as an earnest advocate of potential treatments for otherwise intractable mental illness. Most of Freeman's work took place when state psychiatric hospitals overflowed with seemingly untreatable patients, many of whom suffered relentlessly. Effective psychiatric medications were not yet available, and lobotomy became a measure of last resort. El-Hai describes how neurosurgeons experimented to transform the complicated prefrontal lobotomy into the simpler transorbital lobotomy—nearly an outpatient procedure in which a physician entered a patient's brain through a region above the eye with an ice-pick-like tool. A skilled practitioner could perform a transorbital lobotomy in minutes.

Surprisingly, many of Freeman's lobotomies were reported as successful, not only by Freeman but also by some patients and their families, who sent hundreds of letters expressing gratitude. Of course, many surgeries failed; Rosemary Kennedy, the sister of President John F. Kennedy who suffered "agitated depression," was left "inert and unable to speak more than a few words," as El-Hai says, and was ultimately institutionalized. In 1950 Freeman and Watts reported that of 711 lobotomies they had performed, "45 percent yielded good results, 33 percent produced fair results, and 19 percent left the patient unimproved or worse off." Not surprisingly, many patients remained confused, disconnected, listless and plagued by complications such as seizures. With the emergence of effective drugs during the 1970s, physicians halted lobotomies altogether.

The tale of lobotomy's rise and fall entails far more than one man's quest to spearhead a dubious surgical method. It is a story of desperation among thousands of patients, families, clinicians and policymakers struggling to manage a population seemingly crippled by illnesses for which there was no help. It is also a worrisome account of physicians groping for solutions to problems that they could not adequately address. In this sense, El-Hai's treatment of this medical saga is also poignant and illuminating.

—Richard Lipkin



Match wits with the Mensa puzzler

BY ABBIE F. SALNY

Head Games

1 All the digits from 1 to 9 are used only once in the multiplication example below. Two digits have been filled in. Fill in the others and solve the equation.

? ? 3 X ? ? = ? ? ? 6

2 Fill in the grid below with four words. The answer will contain a total of four As; two each of Ds, Es, Ns and Rs; and one each of L, P, W and H.

H	A	N	D
A			
N			
D			

3 There was a spelling contest at school. Rachel was neither first nor last. Rachel topped Ryan. Ann beat Jane. Charles ended up lower than Jane and higher than Rachel. Who was first?

9 Jane is now as old as John was three years ago cubed. In two years, she will be twice his current age. If you double their ages today, John will be five eighths of Jane's age. How old are they now?

10 The same seven letters can be arranged to form two different words to fill in the sentence below.

Because of a series of _____ security alerts, the plans for the big rally were _____.

4 The following eight letters can be arranged into a three-word phrase meaning "almost helpless."

A C E E K P R U

5 A nine-letter word is hidden in the box below. Unscramble the letters, find the missing one, and solve the puzzle.

D	S	L
O	?	S
I	S	E

6 Which of the following words is least like the others?

CANDLE

HOPPING

JEALOUS

ENDING

CARELESS

7 What is the five-digit number in which the first digit is the second digit squared; the third and fourth digits are the sum of the first and second; and the last digit is the sum of the second, third and fourth digits? The sum of all the digits is 21.

8 Add each line horizontally and vertically. What is the missing sum, and what are the values for each letter?

A	B	C	D	10
A	C	D	D	12
A	C	A	A	6
B	D	B	B	10
5	12	10	?	

Abbie F. Salny, Ed.D., was the supervisory psychologist for American Mensa (www.us.mensa.org/sciamm) and Mensa International (www.mensa.org) for more than 25 years. She is the author and co-author of many challenging puzzle books, including the Mensa Think-Smart Book and the Mensa 365 Brain Puzzlers Page-A-Day Calendar (Workman Publishing).

Answers

1. $483 \times 12 = 5,796$.
2. H A N D
3. Ann. The complete order is Ann, Jane, Charles, Rachel, Ryan.
4. Up a creek.
5. DISSOLVES. The missing letter is V.
6. Jealous. The other words all begin with a common three-letter English word.
7. 93, 126.
8. 11. A = 1, B = 2, C = 3, D = 4.
9. Jane is 8; John is 5.
10. Related, altered.

We have eyes, yet we do not see **BY VILAYANUR S. RAMACHANDRAN AND DIANE ROGERS-RAMACHANDRAN**

How Blind Are We?

PRETEND YOU ARE a member of an audience watching several people dribbling and passing a basketball among themselves. Your job is to count the number of times each player makes a pass to another person during a 60-second period. You find you need to concentrate, because the ball is flying so quickly. Then, someone dressed in a gorilla suit ambles across the floor (*right*). He walks through the players, turns to face the viewers, thumps his chest and leaves. Astonishingly, as Daniel J. Simons, now at the University of Illinois, and Christopher F. Chabris of Harvard University learned when they conducted this study, 50 percent of people fail to notice the gorilla.

We think of our eyes as video cameras that make a flawless recording of the world around us, but this demonstration shows how little information we actually take in at a glance.

The gorilla experiment is the culmination of a long line of related stud-

ies on attention and vision that began more than three decades ago by, among many researchers, Ulric Neisser of Cornell University, Ronald A. Rensink of the University of British Columbia, Anne Treisman of Princeton University, Harold Pashler of the University of California at San Diego and Donald M. MacKay of Keele University in England.

Researchers refer to the gorilla effect as “inattention blindness” or “change blindness,” which in turn is part of a more general principle at work in our visual system. Our brain is constantly trying to construct meaningful narratives from what we see. Things that do not quite fit the script or that are not relevant to a particular task occupying our interest are wiped wholesale from consciousness. (Whether such deleted information is nonetheless processed



See anything unusual? About 50 percent don't.

unconsciously has yet to be investigated.) A simple example of how the brain's running narrative can interfere with perception is the children's game “spot the difference” (*below*). The two images are similar enough that the brain assumes they must be identical; it takes minutes of careful inspection to locate the disparities.

The value of having an underlying brain “story” becomes clear when you consider how jumbled sensory inputs can be. As you survey the room around you, the image on your retina is jumping rapidly as various parts of the scene excite different bits of retina. Yet the world appears stable. Researchers once believed that the experience of having an unbroken view was entirely created by the brain sending a copy of the eye movement command signals originating in the frontal lobes to the visual centers. The visual areas were thought to be “tipped off” ahead of time that the jumping image on the retina was caused by eyes moving and not by the world moving.

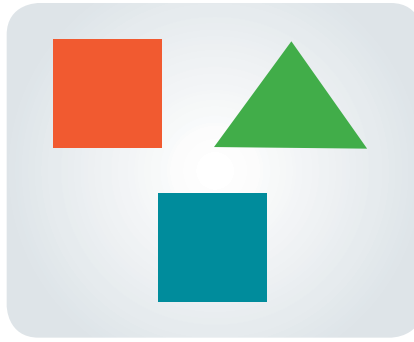
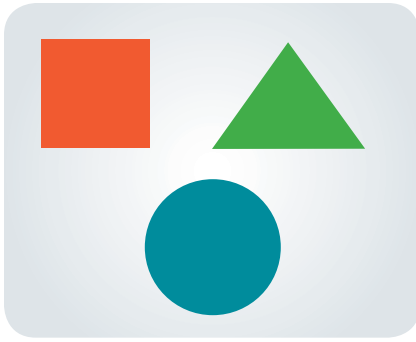
But an effect you can demon-

Continued on page 95



Spot the differences: If two images are similar, the brain assumes they are identical.

D. J. SIMONS AND C. F. CHABRIS, “GORILLAS IN OUR MIST: SUSTAINED INATTENTIONAL BLINDNESS FOR DYNAMIC EVENTS,” IN *PERCEPTION* (PION, LONDON), VOL. 28, PAGES 1059–1074; 1999. FIGURE PROVIDED BY DANIEL J. SIMONS (top); EMILY HARRISON (bottom)



Most people simply will not notice if a shape in one movie frame is changed in the next.

Continued from page 96

strate for yourself at home shows that this cannot be the entire reason. (Jonathan Miller, an opera director in London, and one of us [Ramachandran] independently observed the effect in the early 1990s.) Turn a television set upside down. Gently! Better yet, flip the TV's image optically with a prism. Alternatively, you can turn the TV

they might be physically. In contrast, when the scene is upside down or viewed with peripheral vision and the sound off, it is hard for the brain to make meaningful sense out of what the visual centers perceive, so you start to notice the big changes in the physical image. This effect is not true just for visual scenes on the boob tube but also for your entire life's experiences; the

in position by a small degree. The audience observed that all three appeared to flicker or "glitch" slightly. The big surprise came when we then swapped one of the three shapes—the circle—with a different form—a square (*left*). Most people simply did not notice, except in those few instances when someone accidentally happened to be focusing all his or her attention on that particular object. Even with three simple objects, we experience sensory overload and change blindness.

Finally, imagine that you are staring fixedly at a little red X. Slightly off to the left we briefly show you a cross. All you have to tell us is which is longer—the cross's vertical or horizontal line. That task is something people can do effortlessly. Now we surreptitiously introduce a word directly on the cross during the second that you are judging

(Have you noticed **any gorillas walking by?** How can you be sure that none did?)

sound off and then stand slightly to the side of the set, looking at the screen with your peripheral vision. Put the TV on any channel and watch what happens. You will see sudden, jarring changes and visual jolts. Next, gaze at the broadcast with the TV right side up, viewing it straight on and with the sound at normal volume. Now the cuts and pans of the camera flow smoothly and seamlessly into one another—in fact, you do not even notice them. Even when the scene switches, say, from one talking head to the other as they alternate in conversation, you do not see a head transforming or morphing from one to the other as your mind alternates between each of the two speakers. Instead you experience your vantage point shifting.

What is going on? The answer is that when the TV is right side up and you can hear the sound, the brain can construct a sensible narrative. The cuts, pans and other changes are simply ignored as irrelevant, however gross

unity and coherence of consciousness is mostly convenient, internally generated fiction.

The scene does not have to be complex for change blindness to occur, either. In 1992 Colin Blakemore, now chief executive of the Medical Research Council in London, and Ramachandran conducted an experiment on attendees of a seminar we gave at the Salk Institute for Biological Studies. We first showed a movie frame containing three abstract, colored shapes: a red square, a yellow triangle and a blue circle (*above*). We left this frame up for two seconds, then replaced it with the same three shapes, which were each shifted

line lengths. Arien Mack of New School University and Irvin Rock, then at Rutgers University, discovered that people will not spot the word.

Maybe you are reading this article in a busy cafe. Have you noticed any gorillas walking by? Given the Simons demonstration, how can you be so sure that none did? We suppose it depends on how interesting and attention grabbing you have found this article to be.

VILAYANUR S. RAMACHANDRAN and **DIANE ROGERS-RAMACHANDRAN** are at the Center for Brain and Cognition at the University of California, San Diego.

(Further Reading)

- ◆ **Gorillas in Our Midst: Sustained Inattentional Blindness for Dynamic Events.** Daniel J. Simons and Christopher F. Chabris in *Perception*, Vol. 28, pages 1059–1074; 1999. Paper and video clips are available at http://viscog.beckman.uiuc.edu/djs_lab
- ◆ **Inattentional Blindness.** Arien Mack and Irvin Rock. M.I.T. Press, 2000.
- ◆ Several papers and a demonstration on attention and failure to see change by Ronald A. Rensink and his co-authors are available at www.psych.ubc.ca/~rensink/flicker/